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A botanical cross-section of northern Mississippi, with notes on the influence of soil on vegetation

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(WITH PLATES 21, 22)

INTRODUCTION

The coastal plain of the southeastern United States seems to be more diversified geographically in Mississippi than in any other state, with the possible exception of Florida; and the correlations between geology and vegetation are more obvious there than in any other part of the coastal plain, unless it is in western Alabama. These interesting correlations were graphically described by Dr. E. W. Hilgard in his epoch-making "Geology and Agriculture of Mississippi" in 1860, in the fifth volume of the Tenth Census reports in 1884, and in his text-book on Soils* in 1906. On pages 490–492 of the book last named there is a special phytogeographical sketch of the northern end of the state, between latitudes 34° and 35°, accompanied by an outline map showing the soil provinces or geographical divisions, and a table giving in very condensed form the chemical and physical characters of the soil and a list of a few of the more characteristic trees in each region.

In the summer of 1911 I had occasion to cross the northern half of Mississippi twice, first a little south of the portion last mapped by Dr. Hilgard, and then almost through the center of it. In so doing I crossed all but two or three of the divisions on his map (which form belts approximately parallel to the Mississippi

* Reviewed in Torreya 7: 170–175. 1907.

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River, instead of to the coast as in most other parts of the coastal plain, and therefore running north and south), and I took advantage of the opportunity to make a more complete analysis of the vegetation of each division than had been attempted in that part of the country before. The observations made on that trip, besides embodying some previously unrecorded facts, have led to some conclusions which seem sufficiently new to be offered to the botanical public.

Previous literature. Besides the works of Dr. Hilgard already noted, and a few papers on particular regions, which will be mentioned farther on, the following have an important bearing on the phytogeographical problems of northern Mississippi.

Campbell & Ruffner. A physical survey extending from Atlanta, Ga., across Alabama and Mississippi to the Mississippi River, along the line of the Georgia Pacific Railway, embracing the geology, topography, minerals, soils, climate, forests, and agricultural and manufacturing resources of the country. 8vo. 147 pp. and 2 folded maps. New York, 1883. (Pages 92–96 and 102–107 relate to Mississippi.)

A. B. Hurt. Mississippi: its climate, soil, productions, and agricultural capabilities. U. S. Dept. Agric. Misc. Spec. Rep. no. 3. 89 pp. 1883?. (Contains an annotated list of trees, among other things.)

Sargent & Mohr. (Forests of) Mississippi. U. S. Tenth Census 9: 530–536, and colored map. 1884.

W. J. McGee. The Lafayette formation (in Mississippi). U. S. Geol. Surv. Ann. Rep. **12**[1]: 451–461. 1892.

L. C. Johnson. (Underground waters of) Mississippi. U. S. Geol. Surv. Water Supply & Irrigation Paper 114: 171–178. *f. 23* (geological map). 1905.

A. F. Crider. Geology and mineral resources of Mississippi. U. S. Geol. Surv. Bull. 283. 99 pp. 1906.

Crider & Johnson. Summary of the underground-water resources of Mississippi. U. S. Geol. Surv. Water Supply & Irrigation Paper 159. 86 pp. 6 plates (including colored geological map), 11 text-figs. 1906.

A. F. Crider. A provisional [*sic*] geologic and topographic map of Mississippi. 20 × 28 in., colored. First published in 1907, and issued in connection with several different bulletins of the Mississippi State Geological Survey.

C. E. Dunston (of the [U. S.] Forest Service). Preliminary examination of the forest conditions of Mississippi. Mississippi State Geol. Surv. Bull. 7. 76 pp. (Not dated, but apparently published two or three years ago).

Some of these publications are more useful to botanists than their titles would seem to indicate. There are very few references to the area under consideration in purely botanical literature, doubtless chiefly because nearly all the plants growing there, as far as known, are widely distributed, as I have already pointed out in the case of northwestern Alabama and the Delaware peninsula,* and can be studied more conveniently elsewhere.

Itinerary. On June 6, 1911, I crossed the eastern boundary of Mississippi at McCrary, in Lowndes County, and continued to Columbus, Artesia and West Point by the Mobile & Ohio R.R. In the next few days I traveled almost due westward from West Point, in about latitude 33° 30′, on the "Southern Railway in Mississippi" (formerly Georgia Pacific Ry.), stopping at Carrollton, Greenwood, Itta Bena, Stoneville and Greenville, and making short excursions on foot from each of these places. On the 10th I crossed the Mississippi River at Greenville by going ten or twelve miles upstream to Luna Landing, Arkansas (the nearest railroad point on the other side), which gave me a view of the banks of the river for that distance. On the 16th I re-entered Mississippi near Mineral Wells, in DeSoto County, traveled southeastward on the Frisco System (formerly Kansas City, Memphis and Birmingham Ry.) to Tupelo, then southward on the Mobile & Ohio to West Point and Artesia, and back to Alabama the same way as before. Over a year later, namely, on August 31, 1912, I came into the state near Corinth, in Alcorn County, traveling southward on the Mobile & Ohio R.R. to Tupelo, West Point, etc. The notes made on this last trip have been combined with those of 1911 in making up the list of plants for one of the regions, as will be explained presently.

Method of treatment. The various soil belts described by Dr. Hilgard are not as easily recognized now as they were when he knew them best, for the increase of population and cultivated fields generally tends to obliterate geographical distinctions. And

* Torreya 7: 44–45. 1907; 9: 217. 1909.

as I crossed the boundaries of most of the regions at the rate of 25 to 40 miles an hour, and without ever having seen them before, I was unable to discern some of the distinctions that have been made by those who have explored the territory on foot and made careful studies of the stratigraphy. In the following pages the results of my superficial study of the more conspicuous vegetation of these belts, as far as I could recognize them, are set forth. Notwithstanding its superficiality, this has one advantage over previous studies of Mississippi vegetation in being quantitative.

Under each belt or region named the geology and topography are briefly described, and the percentages of lime, potash, and phosphoric acid in the soil, taken from Hilgard's report on cotton production in the fifth volume of the Tenth Census, are indicated in nearly every case, for purposes of comparison. Additional literature is cited for some of the regions. All those crossed east of Carrollton and Holly Springs extend southeastward into Alabama, where they have been recently described, with quantitative analyses of the forests of each, in my geographical report on the economic botany of that state (Geol. Surv. Alabama, Monograph 8. 228 pp. June, 1913).

The plants identified in each belt are divided first into trees, shrubs and herbs, and then arranged in order of abundance or frequency, with a number indicating how many times each was seen, except in the case of belts so narrow that the frequency numbers would be too small to have much significance. Species seen not more than once in a distance of fifty miles are usually omitted. The names of evergreens are printed in heavy type and those of vines in italics.

THE REGIONS IN DETAIL

From the Alabama line to about three miles west of Columbus, a distance of about 12 miles, the country is underlaid by the Eutaw formation, one of the divisions of the Cretaceous, but the surface is mostly a sandy loam of much more recent age, presumably the Lafayette.* As the railroad in this short distance crosses the Buttahatchee and Tombigbee Rivers and traverses a few

* A description of this part of Mississippi by Dr. Hilgard can be found in the 5th volume of the Tenth Census, pages 296–298.

miles of the bottoms of the latter, the vegetation visible from the train is mostly that of river-bottoms. And as the soil is so fertile that most of it is under cultivation by this time, there is not much natural vegetation left. Most of the shrubs and herbs seen were introduced species, and it is hardly worth while to enumerate them. The commonest trees seem to be *Pinus Taeda*, *Salix nigra*, *Liquidambar*, *Taxodium distichum*, *Quercus Phellos* and *Ulmus alata*, in the order named.

Cretaceous prairie region. From McIntyre (three miles west of Columbus) to Artesia and West Point, thence westward about to the line between Clay and Webster Counties, the country is characterized by a newer Cretaceous formation, the Selma Chalk or Rotten Limestone, with little or no Lafayette loam over it. On the return trip I entered the same belt near the northeastern corner of Pontotoc County, and traversed it lengthwise from Tupelo to Artesia. This is the "northeastern prairie region" of Hilgard's Mississippi reports, a direct continuation of the central prairie region or black belt of Alabama, which has been well described by Smith,* Mohr,† and several less familiar writers.

This prairie region is gently undulating or "rolling," with very few springs or small streams. Its soil, mostly a gray calcareous clay, was once considered the most fertile in the state, with the possible exception of that in the "delta" (described farther on), and consequently most of it has been long given over to agriculture. Analyses of this soil published by Dr. Hilgard show 0.99–1.37% of lime (CaO), 0.33–0.86% of potash (K_2O), and 0.03–0.27% of "phosphoric acid" (P_2O_5). With the possible exception of corn, cotton always has been the principal crop (about 20% of the total

* Tenth Census **6**: 55–58, 68, 128–140 (pages numbered correctly at bottom). 1884; Geol. of Coastal Plain of Ala. 281–285, 350–352, 533–535, 538–539, 576–577, 585, 605–608. 1894.

† Plant Life of Alabama 97–106. 1901. (This however includes two adjoining belts which were not separated by Dr. Mohr.)

The Mississippi portion of the black belt has been described by Hilgard, Hurt (op. cit., 10–12), and Crider (U. S. G. S. Bull. 283: 17–19), and in the government soil surveys of Monroe, Clay, Lowndes, Oktibbeha and Noxubee Counties. Report no. 96 of the U. S. Department of Agriculture, by H. H. Bennett of the Bureau of Soils, and M. A. Crosby of the Bureau of Plant Industry, on the soils of the prairie regions of Alabama and Mississippi and their use for alfalfa, published late in 1911, contains some interesting descriptions and illustrations of the present condition of the region in both states.

area having been devoted to that crop as long ago as 1880), but in recent years, especially since the approach of the boll-weevil, a great deal of alfalfa has been raised. A large amount of land also is now devoted to pasturage, as in many other parts of the world where agriculture has been long established.

In such a fertile region forests, especially primeval forests, are of course scarce. Some parts of it indeed are said to have been treeless when first discovered, whence the name "prairie"; but it would be hardly possible to determine the location and extent of the original prairie spots with any degree of satisfaction now. However, this is one of the few parts of the South where one can see fields and pastures on the sky-line in many places instead of all woods. The remaining forests are principally of two kinds: oak groves on broad low knolls of poorer soil (Lafayette?), and bottom-land forests near some of the creeks and rivers. The latter doubtless owe their preservation to the fact that the earlier settlers found such land too difficult to drain, and often too insalubrious to live in; but the growing population continually requires more land, and the bottom-land trees are gradually disappearing before the axe of the farmer. Pines are not seen at all in this part of Mississippi, except an occasional solitary specimen of *Pinus Taeda* or *P. echinata*, presumably introduced.

Although very different geologically, and not very similar in climate, there are some striking resemblances between the present appearance of this region and the prairie region of Illinois. Both have comparatively level topography and fertile grayish to blackish clay soil, and streams which fluctuate considerably and are muddy most of the time. Both have very little woodland at the present time (they were much less alike in this respect before the country was settled, though), and almost no evergreens. Luxuriant corn-fields make up a large part of the summer landscape (in Illinois the crop is nearly all corn, but in Mississippi it is about half cotton), and finally in both regions the population is about as dense as extensive agriculture alone will support, and consequently it is practically at a standstill outside of the manufacturing cities.

Just as in the Cretaceous region of New Jersey and Delaware,* the herbaceous flora recognizable from a train consists mostly of

* See Bull. Torrey Club **37**: 425. 1910; Torreya **12**: 221. 1921.

weeds; but even the weeds are rather characteristic of this region, both in Mississippi and in Alabama. The following list of plants is derived from 128 miles of travel through the prairie region in 1911, and from 69 miles over part of the same route (viz., from Tupelo to Artesia and McIntyre) in 1912. The country between Corinth and Tupelo, traversed on the 1912 trip, although mostly underlaid by the same formation, is not taken into consideration in the statistics because it has much more of the superficial sandy loam (Lafayette?), a difference which is strongly reflected in the vegetation. The figures for the two years are kept separate, because one set of observations was made in early summer and one in late summer, which makes a considerable difference in the aspect of the herbaceous vegetation. The first figure in each case is for June, 1911, and the second for August, 1912. Species seen less than three times in traveling these 197 miles are omitted.

TREES

24+7 Quercus stellata
21+5 Salix nigra
15+10 Populus deltoides
18+3 Liquidambar Styraciflua
15+5 Quercus Phellos
13+5 Quercus falcata?
8+3 Quercus marylandica
7+3 Platanus occidentalis
6+4 Hicoria ovata?
7+0 Ulmus alata?
5+2 Celtis sp.
4+2 Quercus nigra
3+3 Quercus pagodaefolia
6+0 Gleditscha triacanthos (introduced?)
5+0 Toxylon pomiferum (introduced)
5+0 Quercus alba
5+0 Hicoria alba?
4+2 Quercus lyrata?
3+0 Fraxinus sp.
3+0 Morus rubra
2+1 Cercis Canadensis
1+2 **Juniperus virginiana**

SHRUBS

19+4 Prunus angustifolia
13+1 Sambucus canadensis
4+5 Cephalanthus occidentalis
7+1 *Brunnichia cirrhosa*
6+0 *Tecoma radicans*
3+2 Rhus glabra
2+2 Sassafras variifolium
3+0 *Smilax glauca*
3+0 Rubus sp.
2+1 **Arundinaria macrosperma**

HERBS

31+18 Sorghum Halepense
37+6 Melilotus alba
18+18 Tripsacum dactyloides
5+21 Ambrosia trifida
24+0 Anthemis Cotula
8+15 Helenium tenuifolium
20+0 Daucus pusillus
0+19 Ambrosia bidentata
19+0 Plantago aristata
10+4 Acuan illinoense
1+9 Chaetochloa sp.
6+4 Ambrosia artemisiaefolia
0+9 Eupatorium serotinum
0+8 Paspalum sp.
8+0 Apocynum cannabinum
0+7 Chamaecrista fasciculata
6+0 Monarda citriodora
6+0 Ratibida pinnata
4+2 Silphium laciniatum
0+6 Vernonia sp.
5+0 Cicuta Curtissii
0+5 Syntherisma sanguinalis
0+5 Bidens sp.
0+5 Xanthium sp.
5+0 Lepidium virginicum
4+0 Boltonia asteroides
4+0 Asclepias tuberosa
4+0 Rumex sp.
2+2 Typha latifolia
0+4 Solidago sp.
0+4 Croton capitatus
0+4 Carduus sp.
3+0 Andropogon scoparius
3+0 Cyperus pseudovegetus
0+3 Conoclinium coelestinum
0+3 Silphium terebinthinaceum
0+3 Gaura Michauxii
0+3 Sporobolus indicus

Assuming the above figures to represent correctly the relative abundance of the species, less than 2% of the woody plants (i. e., individuals, not species) are evergreen. The significance of this fact will be discussed farther on.

The oaks in this region, as in the "delta" region to be described below, are rather puzzling, especially to one who has never seen them before and has no opportunity to stop and examine them closely in the light of descriptions or specimens. Dr. Hilgard* has described some curious forms of oaks in this very region, which ought to be investigated by a competent taxonomist. The comparatively large number of herbs, and the occurrence of a few genuine prairie species, such as *Ambrosia bidentata*, *Silphium laciniatum*, *S. terebinthinaceum*, *S. perfoliatum*, *Mesadenia tuberosa*, and *Polytaenia Nuttallii* (the last three seen only once, and therefore not listed), are reminders of the prairie conditions that once existed in this region.

Pontotoc Ridge. The next younger formation in Mississippi is the Ripley, the uppermost division of the Cretaceous. Its strata are more sandy and therefore less easily eroded and dissolved than the Rotten Limestone, and they give rise to a belt of hills, rather rugged for the coastal plain, known in Mississippi as the Pontotoc Ridge. According to Dr. Hilgard's analyses its soil contains 0.17–0.28% of lime, 0.15–0.37% of potash, and 0.08–0.11% of phosphoric acid; or approximately half as much of these important materials as in the prairie belt.† The Ripley formation and its corresponding topography are wanting in the latitude of Columbus and Greenville, but on the return trip I traversed it for about 15 miles, between New Albany and Sherman.

Although the soil of the Pontotoc Ridge is perceptibly less fertile than that of the neighboring prairies, it is mostly under cultivation now, and one does not get a very accurate idea of its native vegetation by merely crossing it once on a fast train. In the following list the numbers are omitted, because they would be too small to have much significance.

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* Soils 491, 494, 498–502.

† For descriptions of this part of Mississippi see Hilgard, Geol. & Agric. Miss. 83–92. 1860; U. S. Tenth Census 5: 221–223, 292–294. 1884; and the U. S. soil survey of Pontotoc County by Bennett and Winston, 1907.

TREES	SHRUBS
Salix nigra	Sambucus canadensis
Liquidambar Styraciflua	Robinia Pseudacacia
Cornus florida	Prunus angustifolia
Pinus echinata	Sassafras variifolium
Platanus occidentalis	Rhus glabra
Quercus alba	
Quercus falcata	HERBS
Cercis canadensis	Asclepias tuberosa
Liriodendron Tulipifera	Tripsacum dactyloides
Populus deltoides	Cicuta Curtissii
Quercus marylandica	Sorghum Halepense
Quercus stellata	(and several less frequent weeds)

A noteworthy difference between this list and the one next preceding is the presence of *Pinus echinata** and *Liriodendron*, species which do not grow in the richest soils. I am not sure that any of the shrubs and herbs listed could have been found in prehistoric times in the places where I saw them.

Post-oak flatwoods. The oldest Eocene formation in Mississippi underlies the "post-oak flatwoods," which lie immediately west of the Pontotoc Ridge in Union County and of the prairie region in Clay County, and extend southeastward into Alabama. This belt is nowhere more than 15 miles wide, and where I crossed it on the westward trip its boundaries seemed so ill-defined, that I could not very well separate my notes on it from those on adjacent regions. On the way back, however, I had little trouble in locating its western edge near Hickory Flat, and its eastern edge at the western base of the Pontotoc Ridge, near New Albany.

The Lafayette formation seems to be absent in the flatwoods, and the Eocene strata have weathered into a very stiff clay, containing, according to Dr. Hilgard's analyses, 0.08–0.18% of lime, 0.25–0.75% of potash, 0–0.05% of phosphoric acid, and 0.17–0.85% of magnesia. Both its physical and its chemical properties make this soil ill adapted to agriculture, and the region is very thinly settled. This part of Mississippi has been described by Hilgard,† Hurt,‡ and E. J. Hill,§ and in the government soil surveys of Pontotoc, Clay and Oktibbeha Counties.

* Prof. Sargent's map of the pine forests of Mississippi (opposite page 530 of the 9th volume of the Tenth Census) does not indicate the occurrence of any pine at all in this region.

† Geol. & Agric. Miss. 273–288; Tenth Census 5: 224–227, 294–296.

‡ Op. cit., 12–14.

§ Torreya 6: 231–232. 1906. In this interesting paper, based on observations made in Oktibbeha County in 1858, the post-oak flatwoods west of Starkville are

Hickory Flat and New Albany are only 14 miles apart, and between those points I had less than twenty minutes in which to gather the following list of plants.

TREES

Pinus echinata
Quercus stellata
Liquidambar Styraciflua
Salix nigra
Fagus grandifolia
Quercus Phellos
Quercus marylandica
Quercus falcata

SHRUBS

Sambucus canadensis
Rhus glabra
Arundinaria sp.
Cephalanthus occidentalis
Tecoma radicans

HERBS

Sorghum Halepense
Helenium tenuifolium
Typha latifolia
Erigeron ramosus
Tripsacum dactyloides
Rudbeckia hirta
Scirpus Eriophorum

This list is too short to draw many important conclusions from, but the fact that a pine stands at the head is significant. The second tree, *Quercus stellata*, is the one which gives the region its name. Forests of very similar aspect can be seen in the "barrens" of extreme northern Alabama and in the Paleozoic flatwoods of the Coosa valley in Georgia and Alabama.

Eocene red hills. The more hilly portions of the Eocene (i. e., excluding the flatwoods) are traversed by the Southern Railway from the eastern part of Webster (formerly Sumner) County to Carrollton, and by the "Frisco" from the Mississippi River to Hickory Flat. Geologists subdivide the Eocene into several formations, but with the exceptions named above and below, I was not able to correlate these with any marked differences in topography or vegetation. The Southern Railway keeps pretty close to a small river nearly all the way across Webster County, and that probably makes more difference in the appearance of the country between that county and those immediately west of it than the difference in age of the underlying rocks does. West of a line drawn from about Holly Springs to Carrollton, though, the Eocene is covered by a superficial formation which affects the vegetation enough to warrant a geographical separation.

called pine-barrens, evidently on account of the contrast with the pineless prairie region bordering them on the east. (The "*Aletris obovata*" mentioned, judging from the description given, and a specimen which I have since seen in the author's herbarium, seems to have been wrongly identified. The locality is several hundred miles from any known station for that species, and in a very different kind of country.)

The typical Eocene country of northern Mississippi is moderately hilly, with reddish to yellowish clayey soil, some of it derived from the weathering of the Eocene strata, and some belonging to the much more recent Lafayette. According to Dr. Hilgard's analyses these soils contain 0.05–0.09% of lime, 0.09–0.24% of potash, and 0.02–0.09% of phosphoric acid; which is a smaller percentage of the first two than in any other region here described. Like most other parts of northern Mississippi, it is now mostly under cultivation, and primeval forests are scarce. The same belt extends northward into Tennessee and eastward to South Carolina, if not farther.*

The following plants were noted more than once in Webster and Montgomery Counties and the eastern half of Carroll on June 7th, or between Holly Springs and Hickory Flat on the 16th; a total distance of 77 miles.

TREES

32 **Pinus echinata**
21 Liquidambar Styraciflua
21 Salix nigra
9 Taxodium distichum
7 Liriodendron Tulipifera
7 Quercus Phellos
7 Quercus falcata
6 **Pinus Taeda**
6 Quercus marylandica
5 Quercus alba
5 Cornus florida
4 Quercus nigra
3 Carpinus caroliniana
3 Fagus grandifolia
3 Platanus occidentalis
2 Quercus stellata
2 Ulmus alata
2 Quercus Michauxii
2 Populus deltoides
2 Cercis canadensis
2 Castanea dentata

SHRUBS

18 Sambucus canadensis
13 Prunus angustifolia
5 *Brunnichia cirrhosa*
5 Rhus glabra
3 Alnus rugosa
3 Rhus copallina
2 Rubus sp.
2 Cephalanthus occidentalis
2 Robinia Pseudacacia

HERBS

15 Plantago aristata
11 Rubdeckia hirta
8 Anthemis Cotula
7 Physostegia sp.
7 Erigeron ramosus
5 Daucus pusillus
4 Sitilias caroliniana
4 Saururus cernuus
4 Cicuta Curtissii
3 Sorghum Halepense
3 Helenium tenuifolium
3 Cyperus pseudovegetus
3 Asclepias tuberosa
3 Boltonia asteroides
3 Juncus aristulatus
2 Tripsacum dactyloides
2 Eryngium yuccaefolium
2 Koellia flexuosa
2 Rhexia lanceolata?
2 Typha latifolia
2 Ambrosia artemisiaefolia
2 **Juncus effusus**
2 Panicum scoparium
2 Cracca virginiana

* For descriptions of this part of Mississippi see Hilgard, Tenth Census **5**: 231–235, 301–302; and the U. S. soil survey of Montgomery County. For notes on the South Carolina end of the same belt see Bull. Torrey Club **37**: 411. 1910; **38**: 225. 1911.

The pines are probably relatively more abundant now than they were originally, on account of their tendency to spread in old fields, so that the apparent proportion of evergreens among the woody plants (19 per cent) may be too large. But it is very evident that the soil of this region is better adapted to evergreens than is that of most of the other regions discussed in this paper. Ericaceae seem to be entirely absent, and native monocotyledons are not conspicuous. (There is no telling how many of the shrubs and herbs listed are really indigenous here, but probably not more than half.) Of the species enumerated, *Taxodium* and *Brunnichia* are almost confined to the coastal plain, and *Quercus Michauxii* and *Populus deltoides* mainly so as far as the southeastern states are concerned; but the other species are pretty widely distributed.

Yellow loam region. Between Memphis and Holly Springs the topography is much the same as in the region just described, but the surface is covered with a few to several feet of loess, a buff-colored very fine-grained somewhat calcareous silt,* which makes the vegetation considerably different. This is the "yellow loam region" or "brown loam table-lands" of Hilgard, which has no counterpart anywhere to the eastward. Dr. Hilgard's analyses show in this soil 0.24–0.25% of lime, 0.30–0.55% of potash, 0.07% of phosphoric acid, and 0.31–0.48% of magnesia.

Almost every acre of it, except on the immediate banks of streams, has been cultivated at some time or other, and much of it is now badly gullied. No primeval forests were seen, and no shrubs or herbs other than weeds, but probably nearly all the trees listed below grew in the same region in prehistoric times, even if not in exactly the same places where they are now. The following list covers 44 miles, about 12 of which were in Tennessee, but so close to the Mississippi line as not to cause any appreciable error.

TREES	
12 Salix nigra	3 Liquidambar Styraciflua
7 Quercus falcata	2 Platanus occidentalis
5 Quercus marylandica	2 Gleditschia triacanthos
4 Quercus stellata	2 Diospyros virginiana
	2 Quercus alba

* For descriptions of this soil see the works of Hilgard and McGee mentioned near the beginning of this paper, also Hilgard, Am. Jour. Sci. **91**: 319–321. 1866; T. O. Mabry, Jour. Geol. **6**: 273–302. 1897.

TREES (continued)

1 Quercus nigra
1 Quercus Michauxii
1 Taxodium distichum
1 Quercus velutina
1 Liriodendron Tulipifera

SHRUBS

12 Prunus angustifolia
11 Sambucus canadensis
3 *Tecoma radicans*
3 Sassafras variifolium
3 Robinia Pseudacacia
1 Rhus glabra

HERBS

5 Plantago aristata
3 Rubdeckia hirta
2 Sorghum Halepense
2 Asclepias tuberosa
1 Tripsacum dactyloides
1 Daucus pusillus
1 Euphorbia sp.

Quercus nigra is partly evergreen (probably less so here than nearer the coast, though), but with this possible exception no evergreens were seen. Ericaceae and Cyperaceae are likewise rare or absent.

Bluff region. Carrollton is near the brow of a line of bluffs which border the flood-plain of the Mississippi River all the way from Memphis to Vicksburg, and form one of the most prominent topographic features in Mississippi. From Carrollton station (North Carrollton P. O.) the railroad descends rapidly for six or eight miles to the foot of the bluffs, following the valley of a creek. I walked the railroad from North Carrollton to Malmaison, which is near the edge of the flood-plain, and from there northward up into the bluff hills about two miles and back.

Geologists generally map the surface formation of these bluffs ("cane hills," they are called farther south) as loess, but what I saw of it in Carroll County looked almost exactly like the "second bottom" loam along many rivers in the coastal plain of Alabama, and quite different from the more typical loess which I saw a few days later in Arkansas, and between Memphis and Holly Springs. The steeper slopes of the bluffs are strewn in many places with subangular cherty pebbles.

The plants seen along and near the railroad and creek between Carrollton and Malmaison are mostly species characteristic of bottom-lands, as follows.

TREES

Taxodium distichum
Liquidambar Styraciflua
Salix nigra
Platanus occidentalis
Cercis canadensis
Carpinus caroliniana
Betula nigra
Morus rubra
Quercus Michauxii
Acer Negundo
Quercus lyrata
Juglans nigra
Liriodendron Tulipifera
Populus deltoides
Ulmus spp.

SHRUBS

Sambucus canadensis
Cephalanthus occidentalis
Brunnichia cirrhosa
Arundinaria macrosperma
Hydrangea quercifolia
Ampelopsis cordata
Rhus glabra
Hydrangea arborescens
Rosa carolina
Itea virginica

HERBS

Cicuta Curtissii
Saururus cernuus
Juncus effusus
Commelina hirtella
Carex triangularis?
Homalocenchrus oryzoides
Onoclea sensibilis
Carex lupulina?
Spirodela polyrrhiza
Panicum scoparium
Teucrium sp.
Diodia teres*
Euphorbia corollata
etc.

Up on the hills north of Malmaison the vegetation is much like that of ordinary dry woods at moderate altitudes throughout the South, as the following list shows.

TREES

Pinus echinata
Quercus marylandica
Cornus florida
Quercus falcata
Quercus stellata
Quercus alba
Hicoria alba
Quercus coccinea

SHRUBS

Ceanothus americanus
Hydrangea quercifolia

HERBS

Cracca virginiana
Pteridium aquilinum
Meibomia laevigata
Meibomia Michauxii
Koellia flexuosa
Psoralea pedunculata
Antennaria plantaginifolia
Polystichum acrostichoides
Mitchella repens
Dioscorea villosa

Judging from the vegetation, the soil of these hills must be considerably less fertile than that of the same line of bluffs farther south, as described by Dr. Hilgard (who apparently never visited Carrollton and vicinity). *Pinus echinata*, the commonest tree, does not seem to have been reported from this part of Mississippi at all before. It seems never to grow on loess (according to Call, Geol. Surv. Arkansas **1889**[2]: 184. 1891), or in any other very rich soil. This and several other species in the list can stand frequent forest fires, but *Hydrangea* and the three evergreen herbs and two vines grow mostly in ravines, where they are pretty well protected from fire.

The "Delta" (PLATE 21). Next is the "Yazoo delta" or Mississippi bottom. Many of its features can be matched fairly well in

* On sand-bars along the creek between Carrollton and North Carrollton. This species grows in quite a variety of habitats, mostly unnatural, but they all have at least one character in common: exemption from fire.

the flood-plains of smaller rivers, but they are here exhibited on a far larger scale than anywhere farther east. On the Mississippi side the "delta" extends from a few miles north of the northern boundary of the state down to Vicksburg, nearly three degrees of latitude, or 200 miles in a straight line, and has its maximum width of 60 miles about midway, or just in the latitude where I crossed it. Generally speaking, it is a vast plain, sloping gently southward, at a rate of about a foot to the mile, traversed by numerous crooked, sluggish, muddy rivers and bayous, whose banks are usually a little higher than the interstream areas. The larger rivers of the delta, such as the Yazoo and Sunflower, are thirty or forty feet deeper at high water than at low water, have a perceptible current, and are navigable for steamboats most of the year, while the smaller bayous are stagnant much of the time, and fluctuate comparatively little. At least 90% of the area is or has been subject to occasional inundation from the spring floods of the Mississippi River ("Father of Waters"), but the building of levees along the banks of the great river, in the last half century or so, has considerably restricted the overflows.

The soil is mainly a fine gray silt, coarsest on the banks of the larger streams, where the current in times of flood is swiftest. Analyses published by E. A. Smith and E. W. Hilgard show that it contains 0.26–1.35% of lime, 0.30–1.10% of potash, and 0.11–0.30% of phosphoric acid. This is one of the most fertile soils known, according to Dr. Hilgard (Soils, 116, 345), and very little commercial fertilizer has been used on it as yet. Most of the area seems to be under cultivation now (cotton being the principal crop), but there is still considerable primeval forest with splendid hardwood timber.*

There is much valuable information about this region in Humphreys and Abbot's voluminous government report on the physics and hydraulics of the Mississippi River, 1861 (reprinted with additions in 1876). Other references are: E. A. Smith, Proc. A. A. A. S. **20**: 251–262. 1872; C. G. Forshey, Proc. A. A. A. S. **21**: 78–111. 1873; Hilgard, Tenth Census **5**: 85–88, 241–247, 319–321. 1884; Campbell & Ruffner, op. cit. 93–96, 105–107;

* I saw only the middle of the delta, but from all accounts the northern half seems to be most extensively cultivated, and forests consequently more prevalent in the southern half.

Hurt, op. cit. 19–24. The latest paper on the area under consideration is Bulletin 244 of the Office of Experiment Stations, United States Dept. Agriculture, a "Report on the Belzoni* drainage district in Washington County, Mississippi," by H. A. Kipp, 1912. This comprises 55 pages, a map and several diagrams; and from the list of bench marks occupying the last six pages one can get a crude idea of the trees of the region and their relative abundance.

Running north and south near the middle of the "delta" is a narrow low ridge, described by Smith and Hilgard as the "dogwood ridge," and said to be above the reach of all floods. Where I crossed it, about Itta Bena, this ridge seems to be only a few inches high, and it would be hardly noticed by any one not making a special search for it. Even the inhabitants of that neighborhood who were interviewed on the subject seemed never to have heard of it. (It is doubtless more noticeable farther north.) I walked along or near the ridge from Sheppardtown to Itta Bena, eight miles, but the vegetation along there did not seem different enough from that of the rest of the region to be listed separately.

The following plants were seen more than once on June 7th to 9th, inclusive, from the train between Malmaison and Greenville, and on side trips on foot from Itta Bena, Elizabeth and Stoneville, a distance of about 75 miles in all.

TREES

31 Taxodium distichum
26 Liquidambar Styraciflua
25 Salix nigra
18 Gleditschia triacanthos
17 Populus deltoides
12 Ulmus alata?†
11 Quercus pagodaefolia
10 Quercus Phellos
7 Nyssa uniflora
6 Diospyros virginiana
5 Quercus Michauxii
4 Platanus occidentalis
4 Quercus nigra
4 Fraxinus sp.
4 Celtis sp.
4 Acer rubrum tridens?
3 Planera aquatica
3 Quercus lyrata
3 Ulmus americana?
2 Morus rubra
2 Carpinus caroliniana
2 **Ilex opaca**
2 Nyssa sylvatica
2 Hicoria ovata
2 Quercus texana?

SHRUBS

25 *Brunnichia cirrhosa*
18 **Sabal glabra**
6 Sambucus canadensis
5 **Arundinaria macrosperma**
3 Cephalanthus occidentalis
3 *Tecoma radicans*
2 *Rhus radicans*
2 **Bignonia crucigera**
2 *Berchemia scandens*
2 Adelia acuminata

* Also (perhaps more commonly) spelled Belzona.

† Some of this may be *Ulmus crassifolia*, which I was not acquainted with at that time.

HERBS

14 Anthemis Cotula	2 Carex Crus-corvi
4 Daucus pusillus	2 Ambrosia artemisiaefolia
4 Sorghum Halepense	2 Saururus cernuus
3 Cyperus pseudovegetus	2 Monarda citriodora
3 Dracopis amplexicaulis	

There are probably few places in temperate regions where one can see more species of trees in traveling a similar distance through an essentially homogeneous region. Six of those listed are oaks, and if I had been more familiar with the Mississippi valley representatives of that genus I might have identified still more. The only evergreen tree in the list is *Ilex opaca*,* and that is confined to the highest and driest spots, and constitutes considerably less than 1 per cent of the arboreal vegetation. As in other hardwood regions,† the woody plants greatly outnumber the conspicuous native herbs. The abundance of woody vines seems to be characteristic of alluvial habitats and some other rich soils, in various parts of the world.‡ The herbs listed are nearly all weeds.

Taxodium distichum, the commonest tree, is not found on the banks of the navigable streams of the delta, for it apparently cannot stand more than ten or twelve feet of average seasonal fluctuation of water.§ It abounds along the smaller bayous or "lakes," and in the interstream swamps described by Smith, Hilgard and others. At the time of my visit the branches of most of the cypress trees in this region and among the bluffs near Carrollton had many branches dead at the tips. The cause of this condition was not ascertained, but drainage operations may have had something to do with it.

Populus heterophylla, which is said by Sargent‖ to be especially abundant in this region, I saw only once, and that in the outskirts of the city of Greenwood, where it might not have been indigenous.

Besides the species to be noted presently as conspicuous by their absence all the way across the state, the following were not seen at all in the "delta":

* This seems to be the only angiospermous evergreen tree in New England and in several interior states.

† See Bull. Torrey Club **37**: 411–412. 1910.

‡ See Torreya **10**: 62. 1910.

§ See Science II. **36**: 760–761. 28 No 1912.

‖ Silva N. A. 9: 164. 1896.

Terrestrial ferns
Pinus (all species)
Juniperus virginiana
Alnus rugosa
Fagus
Quercus stellata
Quercus falcata
Quercus marylandica
Liriodendron
Sassafras
Nyssa biflora

Banks of the Mississippi (PLATE 22). Of the banks of the "Father of Waters" I can say very little, having seen them only for a few miles, between Greenville, Miss., and Luna Landing, Ark., on June 10th. Nuttall passed by there in January, 1820, and published some observations on the river-bank vegetation in his "Journal of travels into the Arkansa territory" the following year. Lyell traversed part of the same route in March, 1846, and his observations can be found in his "Second visit to the United States," 2: 163–164. 1849.

On the inner sides of bends *Salix nigra* (?) is seen everywhere on sand-bars between high and low water marks, and *Populus deltoides* on more silty soil a little higher up. These trees can probably stand as much seasonal fluctuation as any in the world. They seem to prefer soils poor in nitrogen and rich in inorganic plant foods, and they must be regarded as the pioneers for that particular type of soil. On the outer sides of bends, where the river is eroding its banks, *Liquidambar*, *Arundinaria*, and various other species characteristic of river-bottoms are visible, together with occasional specimens of *Taxodium* in the swamps farther back.

CONCLUSION

Notable absentees. Of the plants which are common in other parts of the coastal plain and rare or absent in northern Mississippi the following occur to me. *Nyssa biflora* was seen only twice, once in Clay County and once in Lowndes; and *Juniperus* was seen only once on the 1911 trip, that in Lowndes County. (It is rather common in the black belt of Alabama.) Ferns are rare, as are nearly all pine-barren plants. The following were not seen at all.

Pinus palustris
Taxodium imbricarium
Tillandsia*
Orchidaceae
Myrica cerifera
Magnolia (all species)
Ericaceae

* In crossing the "delta" I must have been pretty close to the range of *Tillandsia usneoides*, for Nuttall (Travels, 228), in floating down the Mississippi on Jan. 22,

Relation of flora to precipitation and soil texture. The absence of *Taxodium imbricarium*, *Magnolia glauca*, and other bog plants from northern Mississippi is correlated with the seasonal distribution of rainfall, among other things. In the greater part of the coastal plain, summer is the rainy season; but in the "Mississippi embayment" portion, which is farthest inland, the winters are wetter than the summers, just as in the interior hardwood region, of which this might be regarded as forming a part. At Water Valley, Yalobusha County, which is pretty close to the center of the northern half of Mississippi, meteorological records for a period of twenty years show that only 30.3 per cent of the normal annual precipitation comes in the four warmest months, June to September, and 41.9 per cent in the six warmest months, May to October.* (March is usually the wettest month and October the driest.)

This type of seasonal distribution of rainfall makes all streams, and the ground-water too, high in spring and low in fall; while in the pine-barren portions of the coastal plain the greater evaporating power of the sun in summer is largely counterbalanced by the increased rainfall at that season, and consequently the water-level is much more uniform there, and conditions are favorable for the development of peat and of bog plants. Ponds and swamps are scarce in northern Mississippi, except in the "delta," where they are caused by the topography, in spite of the climatic conditions just described.

Another factor perhaps still more important in determining

1820, first met it at Cypress Bend, about 20 miles below the mouth of the Arkansas River; and one of the bends near Greenville is named "Spanish Moss Bend." The same plant was reported from along the Cumberland River in Stewart County, Tennessee, by Dr. J. M. Safford, state geologist of Tennessee, in Garden & Forest **3**: 81. 1890.

* For data of seasonal distribution of rainfall in some other parts of the coastal plain see Bull. Torrey Club **37**: 415–416 (footnote). 1910; Florida Geol. Surv. Ann. Rep. **3**: 215. 1911. The interior hardwood region has been briefly defined in Torreya **12**: 146. 1912. The map by Gannett there referred to shows for the whole United States the percentage of rainfall for "the six warmer months, April to September inclusive." But in most places in the eastern United States October is usually a little warmer than April; and furthermore it is usually drier than April in the regions that have dry summers, and wetter than April in the regions that have wet summers, so that the figures for May to October give greater contrasts than do those for April to September.

the character of the flora of northern Mississippi is the prevalence of clayey soils, contrasting strongly with the sand of the pine-barrens nearer the coast. Sand is here chiefly confined to the beds of creeks and rivers, as it is in most of the interior hardwood region. The character of the soil may not be wholly independent of the seasonal distribution of rainfall, but it would be too much of a digression to discuss the matter here. Suffice it to say that it happens that in the Eastern United States most regions with wet winters and dry summers have fertile clayey soils, and where the reverse is true sandy soils predominate.

Some relations of vegetation to soil chemistry. Dr. Hilgard, in his earliest and latest books (1860 and 1906), and in various other works, has always stressed the importance of chemical composition of soil, especially the percentage of lime, in determining the character of the vegetation. In his "Soils," page 490, as already noted, he gives the lime percentages for each soil belt of northern Mississippi, and describes the corresponding vegetation briefly. Similar correlations have been made in Europe by a number of investigators, and the fertility of calcareous soils has been long proverbial. Limestone is one of the commonest and most easily recognized minerals, so that such correlations are easily made; but in the light of the observations made on this trip, and other recent investigations, it is highly probable that some of the other mineral ingredients of soils which do not manifest themselves so conspicuously may be equally important to vegetation.

In the case of lime there always has been a difference of opinion as to just how much of it a soil should contain to be called calcareous. According to Dr. Hilgard, in Europe a soil is not usually called calcareous unless it effervesces with acid, which requires about 5% of lime (calculated as CaO)*; while in this country many soils containing only 1% of lime differ as much in their vegetation from those which have less as they do from some derived from nearly pure limestone. He concludes that calcareous soils are distinguished better by their vegetation than by any arbitrary chemical standard; but here another difficulty is encountered. Just what is calciphile vegetation?

Various European investigators, Schimper† for example, have

* In this connection see Plant World **15**: 300–301. 1912.

† See pages 94–106 of his Plant Geography, English edition. 1903.

published lists of calciphile plants for particular regions, and in temperate eastern North America certain plants, mostly trees, have become by common consent, as it were, accepted as indicators of calcareous soils. Dr. Hilgard lists quite a number of these in each of his books, and even goes farther and distinguishes different forms of the same species characteristic of different kinds of soil. But none of these writers seem to mention any characters which their calciphile plants have in common, so that if a person totally ignorant of mineralogy should travel around the world he could identify the limestone regions only by knowing the individual species which have been listed as calciphile; and the flora changes almost completely every thousand miles or so in temperate regions.

As a matter of fact, the supposed lime-loving trees listed by Hilgard and others in this country do have some characters in common. They are all deciduous except the cedar (and I have recently shown that that is not necessarily calciphile*), and many of them have durable dark-colored heart-wood, thin leaves, and large seeds. But trees with similar characters, and indeed most of the same species, can be also found in many places where the soil is poor in lime or at least not commonly regarded as calcareous, and associated with other species which have not been hitherto regarded as calciphile. Coville in his work in Arkansas a quarter of a century ago found that the difference in the vegetation of sandstone and limestone areas in close proximity was more quantitative than qualitative; i. e., the species were nearly the same, but their relative abundance differed considerably in the two areas.†

Comparatively few observations on calciphile vegetation in tropical and cold-temperate regions seem to have been made. In Schimper's Plant Geography less than a page (380) is devoted to the effects of lime on vegetation in the tropics, and he believes its influence to be less there than in temperate regions. In extreme southern Florida, including the Keys and most of the mainland south of Miami, the rock is nearly all limestone,‡ and there

* Torreya **12**: 145–154. 1912.

† See Arkansas Geol. Surv. Rep. **1888**[4]: 246–247. 1891.

‡ I have no analyses of the mainland rock, but that of the Upper Keys is said to be over 90% calcium carbonate.

is very little soil on top of it. But almost none of the trees regarded as calciphile in the states farther north are found there, and the question arises, are the numerous species of trees growing on limestone in South Florida (nearly all of them tropical) true calciphiles? They are certainly very different in aspect from the supposed lime-loving trees of Mississippi, being nearly all evergreen. Furthermore, some of the commonest species, the pine especially, flourish equally well in sandy soils a little farther north, which are very poor from an agricultural standpoint.

Let us see now if there is not some soil ingredient other than lime which is of fundamental importance to vegetation. One of the most convenient and at the same time perhaps the most significant characters of arboreal vegetation that can be expressed quantitatively is the percentage of evergreens, and this has been already indicated roughly for most of the soil belts described above. The percentages of certain soil ingredients also have been given, and it will be noticed that in the regions under consideration the evergreens can be correlated with *potash* just about as well as with lime, evergreens being scarcest in the soils richest in potash. This relation is still more apparent when we compare northern Mississippi, where nearly all the soils are pretty well supplied with potash, with Florida, where soil conditions are very different. Florida has a larger proportion of evergreens than any other state in the Union, and at the same time its soils are poorest in potash, though fairly well supplied with lime.* It is altogether likely that the limestones of South Florida above mentioned are deficient in potash, though I have too few data on this point as yet. Statistics collected by Hilgard in his book on Soils show that the percentage of potash in tropical soils is usually less than in those of temperate regions; and it is barely possible that the prevalence of evergreens in the tropics may be due partly to this fact, and not to climate alone, as has been hitherto supposed. In temperate

* On page 11 of Bulletin 85 of the U. S. Bureau of Soils, published late in 1912, there is a table of the average chemical composition of the soils of each state, based on over a thousand analyses. The average of 88 samples from Florida is 0.03% of potash and 0.31% of lime. The corresponding figures for four typical hardwood states are as follows: Kentucky, 92 samples, 0.35% potash, 0.18% lime; Ohio, 57 samples, 0.25% potash, 0.29% lime; Tennessee, 144 samples, 0.28% potash, 0.20% lime; West Virginia, 14 samples, 0.53% potash, 0.16% lime.

climates evergreens abound in and near peat bogs and are scarce in clayey soils, and it is well known that potash is scarce in peat and abundant in clay.

Just why potash should be antagonistic to evergreens is an ecological problem that need not be discussed here; for at present I am merely pointing out the geographical correlation. The reasons why this correlation has not been made before are probably first because potassic rocks are not conspicuous and identifiable at sight like limestone, and second because the percentage of potash in the soil varies between much narrower limits than does that of lime, and most soils in inhabited regions have enough potash for the average plant. But it has been proved by many experiments that in an artificial soil containing no potash at all nothing will grow; and it is therefore reasonable to assume that between this artificial condition produced in the laboratory and natural soils containing an average amount of potash there must be intermediate stages where the vegetation is very different from what it is on the average soil. As potash seems to be more abundant in leaves than in any other part of a plant it is natural that a deficiency of this substance should manifest itself first in the leaves, and that plants which do not have access to much potash should have smaller leaves than those of rich soils, and keep them longer.

GEOLOGICAL SURVEY OF ALABAMA, UNIVERSITY

Explanation of plates 21, 22

FIG. 1. Level dry woods about two miles north of Sheppardtown, Leflore County, approximately on the "dogwood ridge." The most conspicuous trees are *Nyssa sylvatica* (in foreground), *Quercus nigra*, and *Ilex opaca*. June 8, 1911.

FIG. 2. Bayou at Quito, Leflore County, looking west from wagon bridge. Trees mostly *Taxodium distichum* and *Nyssa uniflora*. The dead branches in the water indicate the absence of current. June 8, 1911.

FIG. 3. Eroding bank of Mississippi River on outer side of bend about two miles above Greenville, Washington County. Shows *Taxodium distichum*, *Populus deltoides*, *Salix*, etc. June 10, 1911.

FIG. 4. Nearer view of same (eastern) bank of river a little farther upstream, showing numerous vines, *Platanus occidentalis*, etc. June 10, 1911.

Studies in the Agalinanae, a subtribe of the Rhinanthaceae*

Francis W. Pennell

II. Species of the Atlantic coastal plain

Following a survey of the nomenclatural history of the group of Rhinanthaceous plants, which we would term for convenience the Agalinanae, there should properly come some comparative morphological study of the several genera. It has seemed advisable, however, to defer such for the present, in order first to present the results of a season's field-study of the group in the Coastal Plain of the South Atlantic and East Gulf states.

The present paper includes a revision of the species known to occur in the Atlantic Coastal Plain from New Jersey to eastern Louisiana. The flora of the northward extension of this area—Long Island and southeastern Massachusetts—has not been included, as this region is so narrow and broken, and the Coastal Plain flora so attenuated, as scarcely to make such inclusion desirable. From New Jersey southward and westward to central Alabama the Fall Line has been followed as the natural inland boundary. But toward the west instead of turning northward to include the lower Mississippi Valley, an arbitrary line has been drawn on the 33d parallel to the Mississippi River, the western limit of this study. It is believed that while sufficiently diverse the flora of the region included has so much in common, and so much in contrast to the districts northward and westward as to warrant a special consideration.

Four genera of Agalinanae occur within this area. Of these *Macranthera* is monotypic and wholly restricted to this region, *Afzelia* with two species east of the Mississippi River is nearly so restricted, *Aureolaria*, primarily a genus of the Appalachian district, has several species adapted to this region, while *Agalinis*, the largest genus, here reaches its greatest diversity and abundance.

* Contribution from the Botanical Laboratory of the University of Pennsylvania.

In the late summer and early autumn of 1912, I was able to spend over two months in field-study of this group, and the following itinerary indicates the more important points in the Coastal Plain where collections were made:

Abita Springs, St. Tammany Parish, Louisiana	August	11–19
Catalpa, West Feliciana Parish, Louisiana	"	20–26
Biloxi, Harrison Co., Mississippi	"	27–29
Theodore, Mobile Co., Alabama	August	30–Sept. 4
Mobile, Mobile Co., Alabama	Sept.	5
Bay Minette, Baldwin Co., Alabama	"	6–8
Milton, Santa Rosa Co., Florida	"	9
Milligan, Santa Rosa Co., Florida	"	10
Florala, Covington Co., Alabama	"	11–15
Chipley, Washington Co., Florida	"	16–18
Apalachicola, Franklin Co., Florida	"	19–21
Tallahassee, Leon Co., Florida	"	22–24
St. Marks, Wakulla Co., Florida	"	25–26
Monticello, Jefferson Co., Florida	"	27
Thomasville, Thomas Co., Georgia	"	28–30
Valdosta, Lowndes Co., Georgia	Oct.	1
Cordele, Crisp Co., Georgia	"	2–4
Douglas, Coffee Co., Georgia	"	4
Waycross, Ware Co., Georgia	"	5–6
Jacksonville, Duval Co., Florida	"	7–8
Brunswick, Glynn Co., Georgia	"	9–10
Charleston, Charleston Co., South Carolina	"	11–13
Monks Corner, Berkeley Co., South Carolina	"	14
Wilmington, New Hanover Co., North Carolina	"	15–16
Rocky Mount, Nash Co., North Carolina	"	17
Weldon, Halifax Co., North Carolina	"	18

Altogether about 300 numbers of Agalinanae were collected, and a field-study of each species made. These collections and notes form the basis of this report.

In connection with this material I have also reviewed the specimens from the Coastal Plain in the herbaria of the following institutions: United States National Museum, Missouri Botanical Garden, Field Columbian Museum, Biltmore Herbarium, New York Botanical Garden, Academy of Natural Sciences of Philadelphia, University of Pennsylvania, Charleston Museum, Tulane University, Florida Agricultural College, also in the private herbaria of Dr. E. L. Greene, C. C. Deam and H. H. Bartlett. To the custodians and owners of all of these I am greatly indebted.

Also I am indebted to Dr. N. E. Brown of Kew Gardens, England, for consulting Bentham's types in their collections, portions of three of which were kindly sent me; to Dr. A. B. Rendle of the British Museum for examining Walter's types; and to Dr. C. H. Ostenfeld of Copenhagen, Denmark, for comparing the type of *Gerardia tenuifolia* Vahl.

Of the thirty-four species and subspecies in the following pages, all but one have been seen and studied in the field. This exception, *Agalinis oligophylla*, is a Louisiana species not in flower in August when I was there. All new species here proposed have been seen growing, and compared with allies in their native environment. It has been a matter of no small satisfaction that herbarium material since reviewed has fallen so readily into the species deemed valid in the field.

A word may be said concerning field variation in this group. The one species of *Macranthera* and our two of *Afzelia*, as well as all our species of *Agalinis* seem relatively uniform and constant. Breaks between species in the last are often slight but field-study shows them to be true—I have observed little in this genus to suggest hybridism or pronounced subspecific variation. On the other hand, in *Aureolaria*, especially in the subgenus *Panctenis*, conditions seem much more complicated, and such a species as *Aureolaria pectinata* can be viewed only as composed of a number of strains.

In the following treatment the endeavor is made to include quite fully diagnostic characters in the key, while, to save space, only in the case of new species are specific descriptions given. Full synonomy is included so far as Coastal Plain species are concerned. Type localities are quoted from the original descriptions, and where types have been examined the fact is noted. No types have been found for Rafinesque's species. The type of *Gerardia tenuifolia leptophylla* Benth.* has not been as yet identified. The flowering and fruiting seasons are from specimens seen, but are necessarily incomplete. North and south the flowering season is about the same for a given species, possibly a little later south. All definiteness in season seems to be lost in southern

* Hook. Comp. Bot. Mag. 1: 174. 1835. "Jacksonville, Louisiana." *G. tenuifolia filiformis* Benth. in DC. Prodr. 10: 518. 1846, is the same plant.

Florida. Distribution notes are made as definite as practicable.* All localities from which specimens have been seen are listed, and in the case of specimens of my own collecting numbers are given. Of course many specimens have been seen with data too vague for such classification. In the fuller revision of this group upon which the writer is working it is intended more fully to index specimens seen.

In prosecuting this study I have been most deeply indebted to the following three gentlemen: to Mr. Roberts Le Boutillier, of Wayne, Pa., whose generosity enabled me to accomplish the field-work required, to Dr. Roland M. Harper whose knowledge of the flora of the Southeast, most generously imparted, has made my search far more successful than it otherwise could have been, and to Dr. John M. Macfarlane, under whose direction and constant support this study has been made.

Key to the coastal plain genera

Corolla tubular, orange, its base thickened, fleshy, semi-persistent, shriveling and blackening before falling. Filaments equal, long-exserted, pubescent with beaded hairs. Anther-sacs closely parallel, opening their entire length. Capsule ovoid, acuminate, densely and closely pubescent. Seeds winged. 1. *Macranthera.*

Corolla with inflated throat or spreading lobes, yellow or purple, not fleshy nor semi-persistent. Filaments not long-exserted, pubescence not beaded.

Corolla nearly rotate, tube short, lobes longer than tube, yellow. Filaments nearly equal, about the length of the corolla-tube; anther-sacs closely parallel, opening by short apical slits. Capsule ovoid, acute. Seeds wingless or winged. 2. *Afzelia.*

Corolla with inflated throat, tubular-campanulate, lobes much shorter than tube. Filaments didynamous, included; anther-sacs opening their entire length.

Corolla yellow. Anther-sacs parallel, awned at base. Capsule acute to acuminate. Seeds wingless or winged. 3. *Aureolaria.*

* In summarizing local distribution I have largely adopted the floristic areas outoutlined in the following publications: W. Stone—Plants of Southern New Jersey—Ann. Rep. New Jersey State Mus. [**1910**]: 1912; F. Shreve *et al.*—Plant Life of Maryland—Maryland Weather Service **3**: 1910; R. M. Harper—Vegetation of the coastal plain—Bull. Torrey Club **37**: 405–428, 1910; R. M. Harper—Altamaha Grit Region of Georgia—Ann. New York Acad. Sci. **17**: 1. 1906. R. M. Harper—Preliminary Report on Peat—Florida Geol. Surv., Ann. Rep. **3**: 199–375. 1911; C. Mohr—Plant Life of Alabama—Contrib. U. S. Nat. Herb. **6**. 1901; R. M. Harper—Geographic Report on Forests—Geol. Surv. Alabama Monograph 8. 1913.

Corolla pink or purple. Anther-sacs more or less divergent, obtuse to mucronate-awned at base. Capsule rounded at apex. Seeds wingless. 4. *Agalinis.*

1. MACRANTHERA "Torr."; Benth. in Hook. Comp. Bot. Mag. 1: 174. 1835–6

One species:

1. MACRANTHERA FLAMMEA (Bartram) Pennell, Bull. Torrey. Club 40: 124. 1913

Gerardia flammea Bartram, Trav. 412. 1791. "Stony gravelly heights" along Tensaw River* near "Taensa," Alabama. No type specimen known to exist. Identified by Mohr, Plant Life of Alabama, 15. 1901.

Conradia fuschioides Nutt. in Jour. Acad. Nat. Sci. Phila. 7: 88. 1834. No locality given. Type, without data, seen in Herb. Acad. Nat. Sci. Phila.

Macranthera fuchsioides (Nutt.) Benth. in Hook. Comp. Bot. Mag. 1: 174. 1835–6.

Macranthera Lecontei Torr. in Ann. Lyc. Nat. Hist. New York 4: 80. *pl. 4.* 1837. "In dry pine woods on the Alatamaha, in Liberty County, Georgia." Type, without data, seen in Herb. Columbia University.

Russelia flammea (Bartram) Raf. New Fl. Am. 2: 71. 1837.

Flamaria coccinea Raf. New Fl. Am. 2: 71. 1837. Additional name for *Russelia flammea* (Bartram) Raf.

Toxopus gymnanthes Raf. New Fl. Am. 2: 72. 1837. Additional name for *Macranthera Lecontei* Torr.

Toxopus calycinus Raf. New Fl. Am. 2: 72. 1837. Additional name for *Macranthera fuchsioides* (Nutt.) Benth.

Tomilix bracteata Raf. New Fl. Am. 2: 72. 1837. Additional name for *Macranthera fuchsioides* (Nutt.) Benth.

Macranthera fuchsioides Lecontei (Torr.) Chapm. Fl. So. U. S. 297. 1860.

Conradia Lecontei (Torr.) Kuntze, Rev. Gen. 1: 459. 1891.

Though somewhat variable, when in flower the calyx-lobes are mostly entire, linear, relatively short as compared with corolla-tube [= M. Lecontei], later the corolla shrivels and

* Eastern arm of Mobile River.

contracts, but persists, while the calyx-lobes continue to grow, becoming quite lobed and leaf-like [= M. fuchsioides].

Flowers, August to October. Fruit, September to October.

DISTRIBUTION: Borders of wet sandy thickets, in lower coastal pine belt and coast district, southern Georgia and northern Florida to southern Mississippi. Frequent in pine hill region of northwestern Florida, and in southern Alabama. Restricted to the coastal plain.

PLANTS AND SPECIMENS EXAMINED:

Georgia: Probably Liberty Co., *LeConte;* Thomasville.

Florida: Quincy; Beverly (*4681*); Argyle; Crestview; Milligan (*4595*); Milton (*4564*); Bluff Springs.

Alabama: McRae (*4641*); Bay Minette (*4553*); Mobile; Whistler (*4534*); Theodore (*4406, 4459, 4462*).

Mississippi: Ocean Springs; Biloxi.

2. AFZELIA J. F. Gmel. *curante* L. Syst. Nat. ed. 13. 927. 1791

Stem closely pubescent, viscid; leaves pinnatisected, segments lanceolate or broader; calyx-lobes lanceolate; corolla deep yellow, pubescent without, its lobes ovate, 3–3.5 mm. wide; anthers lanose with yellow hairs on dorsal side of connective; capsule ovate, 6–7 mm. long, densely short tomentose with brown hairs; seeds winged. Plant low, 2–6 dm. tall, widely branched. 1. *A. pectinata.*

Stem sparingly pubescent, scarcely glandular; leaves pinnatifid, segments filiform; calyx-lobes linear; corolla pale yellow, glabrous without, its lobes lanceolate, 1.5–2 mm. wide; anthers glabrous; capsule inversely pyriform, 4–4.5 mm. long, glabrous; seeds wingless. Plant tall, 5–10 dm., virgately branched. 2. *A. cassioides.*

1. AFZELIA PECTINATA (Pursh) Kuntze, Rev. Gen. 1: 457. 1891

Seymeria pectinata Pursh, Fl. Am. Sept. 2: 737. 1814. "In South Carolina. *Catesby—v. s. in Herb. Sherard.*"

Seymeria Jacksoni Ell. Sketch 2: 123. 1824. "Sent to me from Louisville, Ga., by Mr. Jackson." Type seen in the Elliott Herbarium at the Charleston Museum.

Seymeria heterophylla Raf. New Fl. Am. 2: 68. 1837. "Alabama and Georgia, my specimen from Leconte."

Flowers, August to September. Fruit, mid-September to October.

DISTRIBUTION: Dry sandy pineland in the coastal plain from

South Carolina to Mississippi, south in the Florida peninsula to Miami. Frequent in southern Georgia and southern Alabama and in Florida. Nearly restricted to the coastal plain.

PLANTS AND SPECIMENS EXAMINED:

South Carolina: Aiken.

Georgia: Augusta; Thomson; Louisville; Brunswick (*4845*); Waycross (*4780*); Thomasville (*4732*); Leslie (*4760*); Columbus.

Florida: Jacksonville; South Jacksonville; San Pablo (*4802*); St. Augustine; Tocoi; Eustis; Palm Springs; Clarcona; Georgiana; Miami; Marco; Tampa; St. Marks (*4705, 4715*); Quincy; River Junction; Liberty Co.; Fort Gadsden (*4686*); Apalachicola (*4674*); Chipley (*4645*); Ponce de Leon (*4656*); Milligan (*4585*); Milton (*4568*); Santa Rosa Island.

Alabama: Auburn; Abbeville; Ozark; Florala (*4630*); Greenville; Wilcox Co.; Mobile Co.

Mississippi: Waynesboro.

2. AFZELIA CASSIOIDES (Walt.) J. F. Gmel. *curante* L. Syst. Nat. ed. 13. 927. 1791

Anonymos cassioides Walt. Fl. Carol. 171. 1788. No type locality given, presumably from Berkeley Co., South Carolina.

Gerardia cassioides (Walt.) Pers. Syn. 2: 154. 1807.

Seymeria tenuifolia Pursh, Fl. Am. Sept. 2: 737. 1814. New name for *Gerardia cassioides* (Walt.) Pers.

Flowers, September to mid-October. Fruit, October.

DISTRIBUTION: Moist to dry pineland, mostly sandy, in the coastal plain from North Carolina to Florida and Louisiana. Frequent in the Wilmington pine barrens, occurs also near Fayetteville, North Carolina, and occasional or frequent southward. Most abundant in flat pine woods of southern Georgia, northern Florida, and near the Gulf coast to Louisiana. In the Florida peninsula reaching Bradentown on the west coast. Mostly in the coastal plain, casually inland in northern Georgia, Alabama, and southeastern Tennessee.

PLANTS AND SPECIMENS EXAMINED:

North Carolina: Wilmington (*4900, 4919*); Fayetteville.

South Carolina: Columbia; Santee Canal; St. Johns; Cooper

River; Monks Corner (*4878*); Otranto (*4872*); Summerville; Charleston (*4866*); Beaufort.

Georgia: Thalmann (*4809*); Coffee Co.; Naylor (*4743*); Moultrie; Thomasville (*4725*); Leslie.

Florida: Jacksonville; St. Augustine; Bradentown; Tampa; Lake City; Monticello (*4719*); St. Marks (*4713*); Quincy; River Junction; Fort Gadsden (*4691*); Apalachicola (*4678*); Chipley (*4649*); Ponce de Leon (*4653*); Milligan (*4588*).

Alabama: Auburn; Abbeville; McRae (*4639*); Bay Minette (*4552*); Mobile Co.

Mississippi: Meridian; Fontainebleau; Ocean Springs; Biloxi; Nicholson.

Louisiana: Covington (*4217*); Hammond.

3. AUREOLARIA Raf. New Fl. Am. 2: 58. 1837

Corolla glabrous without; calyx-lobes entire; seeds winged. Plants perennial, not glandular. **Aureolaria** (*sensu strictu*).
- Capsule glabrous. Flowers evidently pediceled.
  - Stem glabrous, more or less glaucous.
    - Leaves glabrous beneath.
      - Stem quite glaucous. Bracts of a lanceolate type, some at least dentate like the leaves. Capsule 15–20 mm. long. 1. *A. virginica.*
      - Stem slightly glaucous. Bracts of a spatulate type, entire. Capsule about 12–15 mm. long. 2. *A. reticulata.*
    - Stem puberulent. Leaves puberulent beneath. Bracts of a spatulate type, entire. 3. *A. dispersa.*
  - Capsule rusty-pubescent. Plant pubescent throughout. Flowers very short-pediceled. 4. *A. villosa.*

Corolla pubescent without; calyx-lobes dentate to pectinate; seeds wingless. Plants annual, glandular. **Panctenis** (Raf.) subgenus nov.*
- Leaves and stem minutely pubescent or minutely glandular. Pedicels mostly over 10–12 mm. long, exceeding the calyx. Leaves not sharply incised. Calyx-tube turbinate. Capsule ellipsoid.
- Leaves and stem minutely and closely pubescent. Leaves deeply pinnatifid. Stem-leaves mostly 3–6 cm. long.

* *Gerardia* sect. *Pedicularioides* Benth. in Hook. Comp. Bot. Mag. 1: 205. 1835–6, if sectional names have full standing, has priority over *Panctenis* Raf. New Fl. Am. 2: 60. 1837.

Pedicels mostly shorter than or equaling the bracts. 5. *A. pedicularia.*

Stem-leaves mostly less than 2 cm. long. Pedicels longer than the bracts. 6. *A. pedicularia caesariensis.*

Leaves and stem minutely glandular-pubescent. Leaves shallow-pinnatifid, those of the stem mostly 2–3 cm. long. 7. *A. pedicularia carolinensis.*

Leaves and stem densely glandular-pubescent. Pedicels mostly less than 10–12 mm. long, shorter than the calyx. Leaves pinnately lobed, lobes sharply pectinate. Calyx-tube hemispheric. Capsule broadly ovoid.

Stem-leaves all spreading. Flowering pedicel 5–10 mm. long. Flowers about 35 mm. long. Plant widely branched, uppermost leaves smaller, but not excessively reduced. 8. *A. pectinata.*

Stem-leaves, at least the upper, appressed-ascending. Flowering pedicel mostly less than 5 mm. long. Flowers about 40–45 mm. long. Plant virgately branched, uppermost leaves much reduced. 9. *A. pectinata floridana.*

1. **Aureolaria virginica** (L.) Pennell, comb. nov.

Rhinanthus virginicus L. Spec. Plant. 603. 1753. "Habitat in Virginia." Specimen in Gronovius' herbarium identified by Pursh. As specimen in Linnaean Herbarium bears handwriting of Linnaeus the younger, and was probably a later addition, I presume Gronovius' plant to be the type. For discussion see Kuntze, Rev. Gen. 1: 460. 1891.

Gerardia flava L. Spec. Plant. 610. 1753. "Habitat in Virginia, Canada." Specimen in Linnaean Herbarium identified by Bentham in Hook. Comp. Bot. Mag. 1: 198. 1835–6.

Anonymos flava (L.) Walt. Fl. Carol. 170. 1788. As to synonymy, not description, the latter probably applying to *Aureolaria villosa* Raf.

Gerardia lauca Eddy in Med. Repos. N. Y. IInd. Hexade, 5: 126. 1807. Plandome, Long Island. *C. W. Eddy.*

Gerardia quercifolia Pursh. Fl. Am. Sept. 2: 423. 1814. "On the banks of rivers in rich shady places, Pennsylvania to Carolina."

Aureolaria glauca (Eddy) Raf. New Fl. Am. 2: 60. 1837.

Dasystoma quercifolia (Pursh.) Benth. in DC. Prodr. 10: 520. 1846.

Dasystoma flava (L.) Wood, Class Book. 529. 1861. As to synonymy, not description, the latter applying to *Aureolaria villosa* Raf.

Gerardia virginica (L.) Britton, Prelim. Catal. N. J. Pl. 40. 1888.

Dasystoma virginica (L.) Britton in Mem. Torrey Club 5: 295. 1894.

Flowers, in New Jersey, September.

DISTRIBUTION: Frequent on rich slopes, often rocky, in woodland inland, very rare in the Coastal Plain. On wooded slopes at a few points in southern New Jersey.

SPECIMENS EXAMINED:

New Jersey: New Egypt; Nesco; Fairton.

2. AUREOLARIA RETICULATA Raf. New Fl. Am. 2: 59. 1837

Aureolaria reticulata Raf. "Florida and Alabama." No type known to exist.

Dasystoma bignoniiflora Small in Bull. N. Y. Bot. Gard. 1: 285. 1899. "Collected by Dr. Burrows, at Tampa Bay, Florida, in 1834." Type seen in Herb. Columbia University.

Flowers, late-August to mid-October. Fruit, September to October.

DISTRIBUTION: Sandy ravines and moist woodland, both in calcareous and siliceous districts, in the coastal plain from North Carolina to central and western Florida. Apparently most frequent in calcareous region of northern and western Florida. Restricted to the coastal plain; possibly better considered a subspecies of *A. virginica* replacing that species in the southern coastal plain.

PLANTS AND SPECIMENS EXAMINED:

North Carolina: Fayetteville.

South Carolina: Santee Canal; St. Johns; Monks Corner (*4875*); Eding Island.

Georgia: Thomasville (*4723*); Leslie (*4765*).

Florida: Tampa Bay; Monticello (*4720*); Tallahassee (*4696, 4698*); River Junction; Marianna; Milton (*4565, 4566*).

3. **Aureolaria dispersa** (Small) Pennell, comb. nov.

Dasystoma quercifolia intermedia Benth. in DC. Prodr. 10: 520. 1846. No type locality given, nor type specimen known to exist. Description would indicate this species.

Dasystoma dispersa Small, Bull. Torrey Club **28**: 452. 1901. "Louisiana: Feliciana, *Carpenter;* type in the herbarium of Columbia University." Type seen in Herb. Columbia University.

Gerardia dispersa (Small) K. Schum. in Just's Bot. Jahresber. **29**: 580. 1903.

Flowers, August to September. Fruit not seen.

DISTRIBUTION: Sandy thickets and oakland, frequent in coastal pine belt near the Gulf, southern Alabama to eastern Louisiana, reaching Wilkinson Co., Mississippi. Restricted to the coastal plain.

PLANTS AND SPECIMENS EXAMINED:

Alabama: Baldwin Co.; Crichton (*4521*); Hollander's Island (*4504*).

Mississippi: Ocean Springs; Biloxi (*4384*); Long Beach; Wilkinson Co.

Louisiana: Abita Springs (*4117, 4245*); Covington; Feliciana.

4. AUREOLARIA VILLOSA (Muhl.) Raf. New Fl. Am. 2: 59. 1837

Aureolaria villosa (Muhl.) Raf. No type locality given, nor type specimen known to exist. *Gerardia villosa* Muhl. Catal. 58, 1813, and *Gerardia heterophylla* Muhl. l. c. are treated as nomina subnuda.

Dasystoma pubescens Benth. in DC. Prodr. 10: 520. 1846. "In Americae sept. civitatibus orientalibus frequens."

This species has been commonly identified as *Gerardia flava*, but appears not to be *G. flava* L.

Flowers, late-May to mid-August. Fruit, late-July to October.

DISTRIBUTION: Widely distributed in the eastern United States, more common above the fall line. Frequent or occasional in sandy soil in the coastal plain from New Jersey to Louisiana. Not seen from the Florida peninsula. In New Jersey frequent in middle and Cape May districts, less so in the pine barrens.

PLANTS AND SPECIMENS EXAMINED:

New Jersey: Spotswood; Farmingdale; Hornerstown; Medford; Locust Grove; Westville; Clarksboro; Swedesboro; Atco (*3546*); Hammonton; Cape May Court House (*3986*); Bennett; Cold Spring; Cape May.
Maryland: Chestertown.
Virginia: Naucks (*2471*); Cape Henry; Franklin.
North Carolina: Wilmington.
South Carolina: Santee Canal; St. Johns; Bluffton; Aiken; Graniteville.
Georgia: Macon.
Florida: Jacksonville; Chattahoochee River.
Alabama: Ozark Evergreen.
Louisiana: Pearl River.

5. AUREOLARIA PEDICULARIA (L.) Raf. New Fl. Am. 2: 61. 1837

Gerardia pedicularia L. Sp. Pl. 611. 1753. "Habitat in Virginia, Canada."
Anonymos pedicularia (L.) Walt. Fl. Carol. 170. 1788. As to synonymy, probably not description.
Panctenis pedicularia (L.) Raf. New Fl. Am. 2: 61. 1837.
Dasystoma pedicularia (L.) Benth. in DC. Prodr. 10: 521. 1846.

Variable, the following subspecies local, and more or less sharply defined.

Flowers, mid-August to mid-September. Fruit, October. persisting through the winter.

DISTRIBUTION: Widely distributed and frequent in the northern states above the fall line. Rare in the coastal plain where mostly replaced by the following subspecies. Material seen nearly all from New Jersey, where it is rare or absent in middle district, somewhat more frequent in the pine barrens and evidently approaching the subspecies *caesariensis*. (Transitional specimens indicated by asterisk.)

PLANTS AND SPECIMENS EXAMINED:

New Jersey: Middlesex Co.; Brindletown*; Atsion*; Hammonton*.
Pennsylvania: Tinicum (*3589*).

6. **Aureolaria pedicularia caesariensis** Pennell, subsp. nov.

Annual. Stem 10 dm. tall, widely branching, minutely and closely pubescent, very sparingly glandular below. Leaves sessile, ovate-lanceolate, less than 2 cm. long, pinnatifid, segments irregularly crenate-dentate, equaling or longer than the width of the central portion of the lamina, minutely and closely pubescent. Pedicels slender, glandular, 15 mm. long, longer than the calyx, longer than, mostly twice exceeding, the bracts. Calyx-tube glandular with short-stalked glands, equaled by the dentate calyx-lobes. Corolla 35 mm. long, yellow. Capsule 10–12 mm. long, elliptic-ovoid, minutely glandular, surpassing the calyx-lobes.

Type, Atco, Camden Co., New Jersey, Sept. 7, 1911, *F. W. Pennell 3545* in Herb. University of Pennsylvania.

Flowers, mid-August to mid-September. Fruit, October, persisting through the winter.

DISTRIBUTION: Dry sandy pine and oak woods, frequent in the pine barrens of New Jersey, where it mostly replaces the species.

PLANTS AND SPECIMENS EXAMINED:

New Jersey: East Plains; Bamber; Woodmansie; Taunton; Atco (*3545*, *3627*); Middletown, Cape May Co.

7. **Aureolaria pedicularia carolinensis** Pennell, subsp. nov.

Annual. Stem 10 dm. tall, widely branching, minutely glandular-pubescent. Leaves sessile, ovate-lanceolate, 2–3 cm. long, pinnatifid-lobed, segments somewhat crenate, shorter than the width of the central portion of the lamina, minutely glandular-pubescent. Pedicels slender, glandular, 10–20 mm. long, longer than the calyx. Calyx-tube glandular with short-stalked glands, mostly exceeded by the incised-dentate calyx-lobes. Corolla 35 mm. long, yellow. Capsule 12 mm. long, elliptic-ovoid, minutely glandular, equaling or barely surpassing the calyx-lobes.

Type, savannahs near Mill Pond, Wilmington, North Carolina, June 23, 1909, *J. M. Macfarlane* in Herb. University of Pennsylvania.

Flowers, June to September. Fruit, October.

DISTRIBUTION: Dry sandy pine and oak woods, pine barrens of southeastern North Carolina, where it probably replaces the species.

PLANTS AND SPECIMEN EXAMINED:

North Carolina: Wilmington (*4925*) (J. M. Macfarlane in 1909; in 1911); "Southeastern North Carolina," *W. W. Ashe.*

8. **Aureolaria pectinata** (Nutt.) Pennell, comb. nov.

Gerardia pedicularia pectinata Nutt. Gen. Plant. N. Am. 2: 48. 1818. "HAB. In the sandy pine forests of Carolina and Georgia." No type in Herb. Acad. Nat. Sci. Philadelphia.

Gerardia pectinata (Nutt.) Benth. in Hook. Comp. Bot. Mag. 1: 206. 1835–6.

Panctenis pectinata (Nutt.) Raf. New Fl. Am. 2: 61. 1837.

Dasystoma pectinata (Nutt.) Benth. in DC. Prodr. 10: 52. 1846.

Very variable, as here understood, including a number of strains.

Flowers, July to September. Fruit, September to October.

DISTRIBUTION: Dry sandy pineland, especially hilly, in the coastal plain, South Carolina, through southern Georgia, pine hills of northwest Florida, to Alabama and Mississippi, locally frequent extending above the fall line. In some of its forms occurring throughout the Gulf and Lower Mississippi Valley states.

PLANTS AND SPECIMENS EXAMINED:

South Carolina: Eutawville; Santee Canal; Monks Corner; Cooper River; Beaufort.

Georgia: Augusta; Thomson; Americus.

Florida: De Funiak Springs.

Alabama: Florala (*4625*); Flomaton; Prattville; Tensaw; Deer Park; Mobile; Spring Hill (*4532*).

Mississippi: Meridian; Jackson.

9. **Aureolaria pectinata floridana** Pennell, subsp. nov.

Annual. Stem about 10 dm. tall, much branched, glandular-villose. Branches virgate, ascending. Leaves sessile, ovate, those of the stem less than 2 cm. long, pinnatifid, segments pectinately toothed, glandular-villose; at least the upper leaves ascending or appressed to the stem or branches, the uppermost much reduced. Pedicels stout, 5 mm. long or less, shorter than the calyx, glandular-villose. Calyx-tube glandular-villose, much exceeded by the lanceolate, pectinate teeth. Corolla 40–45 (–50) mm. long, yellow, no purple markings within tube (in type specimens). Capsule 12–14 mm. long, broadly ovoid, glandular-pubescent, shorter than the calyx.

Type, Fort Gadsden, Franklin Co., Florida, Sept. 20, 1912, *F. W. Pennell 4683*, in Herb. University of Pennsylvania.

This may be *Gerardia pedicularia pectinata* Nutt., as the mention of short pedicels and very large flowers would suggest, but as *floridana* does not occur in South Carolina, though probably in the flat pine woods of southeastern Georgia, I retain the name for the prevalent species of the district cited. I have seen no old collections of *floridana* from Georgia.

Flowers, May to mid-October. Fruit, June to October.

DISTRIBUTION: Dry sandy pineland. Flat pine woods of Florida and southern Georgia, south to Polk Co., Florida; replacing the species.

PLANTS AND SPECIMENS EXAMINED:

Georgia: Thomasville (*4724*).

Florida: Jacksonville; Pablo; St. Augustine; Eustis; Orange City; Lake Brantley; Polk Co.; Tampa; Marion Co.; Tallahassee; Fort Gadsden (*4683*); Apalachicola.

4. AGALINIS Raf. New Fl. Am. 2: 61. 1837

Perennial, from a running rootstock, glabrous throughout. Pedicels erect, 5–20 mm. long. Corolla slightly fleshy, pink, with darker spots, but no yellow lines within throat, pubescent without, pubescent within at base of upper lobes, 35–40 mm. long. Capsule globose, 5–6 mm. long. Seeds dark brown. [*Linifoliae.*] 1. *A. linifolia.*

Annuals, fibrous rooted, in most at least the upper surface of the leaf scabrous. Pedicels ascending or spreading. Corolla membranous, purple or pink, mostly with darker spots and two yellow lines within throat. Capsule globose or ovoid.

Corolla with lobes all spreading, pubescent within at base of upper lobes, more or less pubescent without.

Seeds dark brown. Plants darkening in drying. Calyx-tube not reticulate-venulose. Corolla purple or pink-purple. Flowers short- or long-pediceled. [*Purpureae.*]

Leaves uniform, linear to filiform-subulate.

Inflorescence of normal racemes; pedicels less than 10 mm. long. Seed-coat with dark brown ribs, between these mostly paler and minutely reticulated.

Leaves and calyx-lobes obtuse to acutish. Anther-sacs obtuse to acutish at base. Plant fleshy, bushy-branched below, with elongated racemes above. Pedicels reaching 10 mm. long. 2. *A. maritima.*

Leaves and calyx-lobes acute to acuminate. Anther-sacs mucronate to minutely awned at base. Plants not fleshy, more uniformly branched. Pedicels less than 5 mm. long.

Corolla purple or pink-purple, 2 yellow lines and darker spots present. Plants dull-green or purplish, much darkening in drying.

Stem smooth or minutely scabrellous. Axillary fascicles slightly or not developed, if present shorter than leaves.

Corolla 20–35 mm. long, rose-purple.

Corolla 25–35 mm. long, on evident pedicels 2–5 mm. long. Stem sparingly scabrellous. Leaves linear, those of the stem 1.5–3.5 mm. broad. Calyx-lobes triangular-lanceolate to triangular-subulate. 3. *A. purpurea.*

Corolla 20–25 mm. long. Leaves narrowly linear to almost filiform. Calyx-lobes triangular-subulate to subulate. Stem essentially smooth.

Stem-leaves narrowly linear to almost filiform, 1.5–3 cm. long, mostly longer than the internodes, mostly curling in drying. Branches mostly simple, ascending, virgate. Axillary fascicles relatively well

developed. Pedicels 2–5 mm. long. 4. *A. virgata.*

Stem-leaves 1–2.5 cm. long, mostly shorter than the internodes. More stiffly branched. Axillary fascicles scarcely or not developed. Flowers nearly sessile, on pedicels less than 2 mm. long. Stem-leaves narrowly-linear, thickened, 2–2.5 cm. long, scarcely or not curling in drying. 5. *A. pinetorum.*

Stem-leaves almost filiform, 1–2 cm. long, curling in drying. 6. *A. delicatula.*

Corolla 15–18 mm. long, pink-purple. Flowers nearly sessile, on pedicels less than 2 mm. long. 7. *A. Harperi.*

Stem scabrous. Axillary fascicles abundantly developed, mostly equaling leaves. 8. *A. fasciculata.*

Corolla lavender-pink, no yellow lines nor darker spots evident, 15–18 mm. long. Plants bright-green, little darkening in drying. Stem smooth or nearly so. Axillary fascicles abundantly developed. 9. *A. georgiana.*

Inflorescence of short or much broken racemes, some flowers, by slower or arrested

growth of stem apex, frequently appearing terminal. Pedicels over 5 mm. long.
Stem scabrous. Anther-sacs evidently awned at base, densely woolly over entire surface. Seed-coat with dark brown ribs, areas between these more or less hexagonal, pale and not reticulated. Stem-leaves opposite, axillary fascicles abundantly developed. Pedicels 15–40 mm. long. Corolla 25–30 mm. long. 10. *A. pulchella.*
Stem glabrous, or essentially so. Anther-sacs acute to minutely mucronate-awned at base, pubescent, glabrous over much of dorsal surface. Seed-coat with dark-brown ribs, areas between these elongated, scarcely paler, and scarcely or not reticulated.
Stem-leaves alternate, narrowly linear to filiform, semi-fleshy, 1–2 cm. long. Axillary fascicles abundantly developed. Pedicels 10–35 mm. long. Corolla 25–30 mm. long. 11. *A. filifolia.*
Stem-leaves opposite. Axillary fascicles scarcely developed or none.
Stem-leaves narrowly linear to filiform-setaceous, 1.5 cm. or longer. Seed-coat with fine parallel ridges, areas between these narrow.
Pedicels less than 30 mm. long. Corolla mostly 20–30 mm. long, rose-purple. Seed-coat with very fine parallel ridges. Plants densely and repeatedly branched, usually with filiform to setaceous leaves.
Pedicels 10–30 mm. long, longer than the bracts. Corolla mostly 20–25 mm. long. Leaves narrowly linear to filiform. Flowers not conspicuously "terminal." 12. *A. Holmiana.*

Pedicels less than 10 mm. long, mostly shorter than the bracts. Corolla mostly 25–30 mm. long. Leaves filiform-setaceous. Flowers conspicuously "terminal." 13. *A. setacea.*

Pedicels, at least in fruit, 25–50 mm. long, very slender, four to five times exceeding the bracts. Corolla 15–18 mm. long, pink-purple. Seed-coat with fewer and slightly heavier ridges. Plant very widely and laxly branched, the lower branches widely ascending. Leaves narrowly linear to filiform. 14. *A. laxa.*

Stem-leaves filiform-subulate, 1 cm. long or less, much shorter than internodes. Seed-coat with broader areas. Pedicels 5–15 mm. long. Calyx-lobes acute, 0.5 mm. long. Corolla 15–20 mm. long. Stem terete, grooved, not angular. 15. *A. oligophylla.*

Leaves dimorphic, basal oval-ovate, spreading, cauline, minute, scale-like, appressed. Pedicels less than 5 mm. long, many flowers appearing to terminate minute axillary branches. Calyx-lobes minute, subulate. Corolla 15–20 mm. long, pink-purple. Stem mostly 4-angled, often pubescent at base. 16. *A. aphylla.*

Seeds yellowish brown. Plants light green, not darkening in drying. Corolla pink. Flowers on pedicels longer than bracts. Calyx-tube reticulate-venulose, lobes minute, callose. [*Erectae.*]

Stem-leaves 2–2.5 cm. long, filiform-linear, acute. Corolla 15 mm. long, lobes more or less emarginate, 2 yellow lines and purple spots evident. 17. *A. decemloba.*

Stem-leaves 1–1.5 cm. long.

Corolla 15–20 mm. long, lobes more or less emarginate, 2 yellow lines and purple spots well developed. Pedicels slender. Leaves nearly filiform, acutish or acute. Plant relatively lax. 18. *A. tenella.*

Corolla 12–16 mm. long, lobes rounded to truncate, 2 yellow lines and purple spots slightly developed or suppressed. Pedicels stouter. Leaves linear, widening upward, obtusish to obtuse. Plant strict, stiff. 19. *A. erecta.*

Corolla bilabiate, two upper lobes ascending over stamens and style, glabrous within at base of upper lobes. Seeds dark brown. [*Tenuifoliae.*]

Corolla pubescent without, 2 upper lobes two-thirds length of lower 3, minutely ciliate, concave-arched. Pedicels, if exceeding the bracts, less than twice their length. Corolla 10–18 mm. long, purple. Leaves linear, those of the stem often broadly so. 20. *A. tenuifolia.*

Corolla glabrous without, 2 upper lobes less than one-half length of lower 3, conspicuously ciliate, flattened. Pedicels at least three times the length of the bracts.

Leaves filiform, those of the stem 1.5–2 cm. long. Pedicels 15–30 mm. long. Corolla rose-pink, 15–18 mm. long. Plant reaching 8 dm. tall, widely much branched. 21. *A. divaricata.*

Leaves minute, scale-like, those of the stem less than .2 cm. long. Pedicels 5–10 mm. long. Corolla lavender-pink, 10–13 mm. long. Plant less than 5 dm. tall, sparingly very laxly branched. 22. *A. filicaulis.*

1. AGALINIS LINIFOLIA (Nutt.) Britton in Britt. & Br., Ill. Fl. ed. 2. 3: 209. 1913

Gerardia linifolia Nutt. Gen. Pl. N. Am. 2: 47. 1818. "HAB. From Wilmington, North Carolina to Florida." Type, labeled "Carolina," seen in Herb. Acad. Nat. Sci. Philadelphia.

Agalinis perennis Raf. New Fl. Am. 2: 63. 1837. "My specimen is from Florida."

Flowers, mid-August to October. Fruit, September to November.

DISTRIBUTION: Wet pineland, and especially margins of ponds, in the coastal plain. Ellendale, Delaware; from Wilmington, North Carolina to southern Florida and near the Gulf coast to Louisiana. Most abundant in flat pine woods of southern Georgia and Florida, less frequent in the west Florida pine hills and in the Altamaha grit region of Georgia, occasional north of the Savannah River or west of Florida. Restricted to the coastal plain.

PLANTS AND SPECIMENS EXAMINED:

Delaware: Ellendale.

North Carolina: Wilmington; Brunswick Co.

South Carolina: Hartsville; Santee Canal; Eutawville.

Georgia: Everett; Brunswick (*4823*); Waycross (*4790*); Naylor (*4745*); Thomasville (*4729*); Sumter Co.; Columbus.

Florida: Tisomia (*4813*); Baldwin; Jacksonville (*4794*); St. Nicholas; San Pablo (*4807*); Cutler; Homestead; Camp Longview; Fort Myers; St. Petersburg; St. Marks (*4714*); Quincy; Fort Gadsden (*4690*); Apalachicola; Chipley (*4648*, *4666*); Ponce de Leon (*4654*); Paxton (*4600*).

Alabama: Elmore.

Mississippi: Biloxi.

Louisiana: Hammond.

2. AGALINIS MARITIMA Raf. in Med. Repos. New York. IInd. hex. 5: 361. 1808 (as *Gerardia*); New Fl. Am. 2: 62. 1837

Gerardia maritima Raf. "Found in the islands of Egg-Harbour, in New Jersey." No type known to exist.

Gerardia purpurea crassifolia Pursh Fl. Am. Sept. 2: 422. 1814. "In salt marshes, near New York."

Gerardia maritima grandiflora Benth. in Hook. Comp. Bot. Mag. 1: 208. 1835–6. "Texas, *Drummond*, 1st Coll."

Gerardia spiciflora Engelm. Bost. Jour. Nat. Hist. 5: 227. 1845. New name for *Gerardia maritima grandiflora* Benth.

Gerardia maritima major Chapm. Fl. So. U. S. 300. 1860. "Brackish marshes, Apalachicola, Florida." There are several collections of Chapman's of this species, but none, indicated as type, has been seen.

Flowers, April (on the Gulf coast) to mid-September. Fruit, August to September.

DISTRIBUTION: Salt marshes, along the Atlantic and Gulf coasts from New Jersey to Louisiana, locally frequent. Extending to Maine northward, in the south to Texas, Yucatan, Cuba and the Bahamas. Along the Gulf coast and Atlantic coast in Florida a much branched plant, reaching 6 dm. tall, leaves and calyx-lobes more liable to be acutish, pedicels mostly exceeding the bracts, corolla reaching 20 mm. long, and anther-sacs lanose-

pubescent, northward becoming progressively smaller and simpler, till a plant of but 0.5–1.0 dm. tall in Maine, leaves and calyx-lobes constantly obtuse, pedicels shorter than the bracts, corolla scarcely 15 mm. long, and anther-sacs nearly glabrous.

PLANTS AND SPECIMENS EXAMINED:

New Jersey: Keasbey; Long Beach; Forked River; Barnegat Pier; Beach Haven; Atlantic City; Ventnor; Mays Landing; Ocean City; Palermo; Sea Isle; Peermont; Cape May Court House (*2604*); Holly Beach; Five-mile Beach; Cold Spring (*2157*); Cape May.
Delaware: ——, *Bernhardi*.
Maryland: Ocean City.
Virginia: Parksley; Walnut Point.
North Carolina: Ocracoke Island; Beaufort.
Florida: Titusville; Eau Gallie; Marco; Sanibel; Pine Island; Tampa; Long Key, Pinellas Co.; Hernando Co.; St. Marks (*4702*); Apalachicola.
Alabama: Mobile Co.
Mississippi: Ship Island.
Louisiana: Breton Island.

3. AGALINIS PURPUREA (L.) Pennell, Bull. Torrey Club **40**: 126. 1913

Gerardia purpurea L. Sp. Pl. 610. 1753. "Habitat in Virginia, Canada."
Anonymos purpurea (L.) Walt. Fl. Carol. 170. 1788.
Gerardia purpurea grandiflora Benth. in Hook. Comp. Bot. Mag. **1**: 208. 1835–6. "New Jersey."
Agalinis palustris Raf. New Fl. Am. **2**: 62. 1837. "Near marshes. . . . From New England to Carolina."
Agalinis longifolia Raf. New Fl. Am. **2**: 62. 1836. "Near streams New Jersey to Virginia."
(?) *Agalinis corymbosa* Raf. New Fl. Am. **2**: 63. 1837. "Carolina and Florida."

Flowers, mid-July to mid-October. Fruit, late-September to October.

DISTRIBUTION: Moist sandy soil, nearly throughout the coastal

plain. Abundant from New Jersey to South Carolina, in New Jersey in the middle district and coastal strip, absent from the New Jersey, probably also from the Wilmington, N. C., pine barrens; southward abundant near the coast in Georgia, extending to the Florida Keys, of occasional occurrence in the Altamaha grit region of Georgia, more common inland. Westward occasional, especially near the Gulf coast, and probably frequent north of the pine belts. A characteristic plant of coastal regions, edges of salt marshes. Widely distributed in the eastern United States, most abundant in the coastal plain.

PLANTS AND SPECIMENS EXAMINED:

New Jersey: Keasbey; South River; Spotswood; Keyport; Farmingdale; New Egypt; Burlington; Delair; Griffith's Swamp; Kirkwood; South Westville; Clarksboro; Mickleton; Swedesboro; Deal; Belmar; Chadwick; Toms River; Seaside Park; Forked River; Waretown; Barnegat Pier; Cox's; Manahawken; Absecon; Atlantic City; Ventnor; Ocean City; Ocean City Junction; Avalon (*4004*); Wildwood; Middletown; Cape May Court House (*2602*, *2603*); Bennett; Cape May.

Pennsylvania: Tinicum (*3598*).

Delaware: Porter; Ellendale; Rehoboth.

Maryland: Kent Island; Abbey's Island; Laurel; Lanham; Buena Vista (*2640*); College Park; Hyattsville; Bladensburg.

District of Columbia: Anacostia; Terra Cotta (*2678*, *2679*); Holmead Swamp; District Line (*2639*); Washington.

Virginia: Alexander Island (*2671*); Arlington (*2672*); Alexandria; Four-mile Run; Seven Pines (*4946*); Smith's Island; Norfolk; Virginia Beach; Munden.

North Carolina: Weldon (*4948*); Rocky Mount (*4932*); Wilmington (*4914*, *4927*); Southport.

South Carolina: Ebenezer; Santee Canal; Monks Corner (*4876*); Otranto (*4869*); Charleston; Yemassee (*4850*, *4854*); Bluffton; Aiken.

Georgia: Thomson; Thalmann (*4811*); Waycross (*4784*); Fitzgerald; Naylor (*4746*, *4753*); Thomasville (*4735A*); Cordele (*4769*); De Soto (*4758*); Leslie (*4767*).

Florida: Jacksonville (*4799*); San Pablo (*4806*); Miami; Black

Point; Homestead; Camp Longview; Long Prairie; Bull Key; Cape Florida; Fort Myers; Lakeland; St. Petersburg; Lake City; St. Marks (*4703*); Apalachicola.

Alabama: Mobile.

Mississippi: Ora; Long Beach; Pass Christian (*4357*).

4. AGALINIS VIRGATA Raf. New Fl. Am. 2: 62. 1837

Agalinis virgata Raf. "Glades of Pine woods in South New Jersey near Mullica Hill, &c." No type known to exist.

Gerardia racemulosa Pennell Torreya 11: 15. 1911. "Type.—Parkdale, Camden Co., N. J., *F. W. Pennell 2692* Coll. Sept. 27, 1910, in Herb. Acad. Nat. Sci. of Phila."

Flowers, September to mid-October. Fruit, mid-September to October.

DISTRIBUTION: In the coastal plain, New Jersey, and North and South Carolina. In New Jersey restricted to the pine barrens where frequent; frequent or common in the Wilmington pine barrens; frequent or occasional in pineland in South Carolina. Replaces *A. purpurea* in typical pine barrens. Restricted to the coastal plain.

PLANTS AND SPECIMENS EXAMINED:

New Jersey: Hornerstown; Forked River; Pasadena; Atsion; Hammonton; Egg Harbor City; Parkdale (*2692, 2694, 3584, 3626, 3808*); Winslow Junction (in 1908).

North Carolina: Newbern; Wilmington (*4902, 4921*).

South Carolina: Monks Corner (*4877*); Eutawville; Charleston.

5. **Agalinis pinetorum** Pennell, sp. nov.

Annual. Plant 6–8 dm. tall, much branched, branches ascending, long and slender. Stem slightly angular, glabrous or nearly so. Leaves opposite, stiffly spreading, narrowly linear, thickened, very scabrous on the upper surface, those of the stem 2–2.5 cm. long. Axillary fascicles scarcely or not developed. Racemes of 8–14 mostly opposite flowers. Pedicels very short, in flower 2 mm. long or less, hardly longer in fruit. Calyx-lobes triangular-subulate, 1–1.5 mm. long. Corolla 20–25 mm. long, pubescent without, pubescent within at base of upper lobes, rose-purple, 2 yellow lines and purple spots within throat below; lobes all spread-

ing, rounded to emarginate, ciliate. Filaments lanose; anther-sacs oblong, lanose, minutely mucronate-awned at base, 2 mm. long. Style filiform 6–10 mm. long. Capsule globose, 5 mm. long. Seeds not seen.

Type, St. Marks, Wakulla Co., Florida, Sept. 26, 1912, *F. W. Pennell 4708*, in Herb. University of Pennsylvania.

Flowers, late-September to October.

DISTRIBUTION: Moist soil, in pineland, southern Georgia and northern Florida. Probably common in Altamaha grit region, frequent through flat pine woods of northern Florida, west to the Apalachicola River. Restricted to the coastal plain.

PLANTS AND SPECIMENS EXAMINED:

Georgia: Waycross (*4781*, *4791*); Douglas (*4775*); Naylor (*4750*); Thomasville (*4734*, *4738*); Cordele (*4770*, *4771*, *4773*).

Florida: Jacksonville (*4795*); St. Marks (*4708*); Fort Gadsden (*4688*); Apalachicola.

6. **Agalinis delicatula** Pennell, sp. nov.

Annual. Plant 6–8 dm. tall, branched, branches long and very slender. Stem angular, glabrous. Leaves opposite, spreading, almost filiform, scabrous on the upper surface, those of the stem 1–2 cm. long. Axillary fascicles scarcely developed. Racemes of 8–12 mostly opposite flowers. Pedicels very short, in flower 2 mm. long or less. Calyx-lobes subulate, 1.5–2 mm. long. Corolla 20 mm. long, sparingly pubescent without, pubescent within at base of upper lobes, rose-purple, 2 yellow lines but (in this collection) no purple spots within throat below, lobes all spreading, rounded to emarginate, minutely ciliate. Filaments lanose; anther-sacs oblong, lanose, mucronate-awned at base, 1.5 mm. long. Style filiform. Fruit not seen.

Type, Ponce de Leon, Holmes Co., Florida, Sept. 17, 1912, *F. W. Pennell 4661* in Herb. University of Pennsylvania.

Nearest to *A. pinetorum* of which this may possibly prove a form, but the plants seen appeared strikingly distinct, and occurred in a different region, west of the known range of that species.

Flowers, mid-September to October.

DISTRIBUTION: Most sandy pineland, western Florida. Possibly frequent in the west Florida pine hills. Restricted to the coastal plain. Type only seen.

7. AGALINIS HARPERI Pennell in Small, Flora of Miami, 167. 1913

Agalinis Harperi Pennell. "Type.—St. Marks, Wakulla County, Florida. *F. W. Pennell*, 4707 coll. September 25, 1912" in Herb. University of Pennsylvania.

Annual. Plant 4–8 dm. tall, relatively sparingly branched. Stem slightly angular, glabrous or nearly so. Leaves opposite, rather stiffly spreading, narrowly linear, scabrous on the upper surface, those of the stem 2–3.5 cm. long. Axillary fascicles scarcely or not developed. Racemes of 8–20 mostly opposite flowers. Pedicels very short, in flower less than 2 mm. long, hardly longer in fruit. Calyx-lobes triangular-lanceolate to triangular-subulate, 1 mm. long or less. Corolla 15–18 mm. long, pubescent without, pubescent at base of upper lobes within, pink-purple, 2 yellow lines within throat below, small purple spots mostly along these; lobes all spreading, rounded to truncate, ciliate. Filaments lanose; anther-sacs oblong, lanose, acute at base, 1.5 mm. long. Capsule 4–5 mm. long. Seeds reticulated with dark brown ridges, areas between these relatively dark, with finer cross lines.

Flowers, mid-September to mid-October. Fruit, October.

DISTRIBUTION: Moist sandy pineland, borders of salt marsh, etc. Flat pine woods of southern Georgia, south through the Florida peninsula. Apparently most frequent in the Everglades. Restricted to the coastal plain.

PLANTS AND SPECIMENS EXAMINED:

Georgia: Thalmann (*4810*); Thomasville (*4726*).
Florida: Camp Longview; St. Marks (*4701, 4707, 4711*).

8. AGALINIS FASCICULATA (Ell.) Raf. New Fl. Am. 2: 63. 1837

Gerardia fasciculata Ell. Sketch 2: 115. 1824. "Grows principally in lands subject to occasional inundation from the ocean—on Eding's Island near Beaufort very common." Type seen in the Elliott Herbarium at the Charleston Museum.

Gerardia purpurea fasciculata (Ell.) Chapm. Fl. So. U. S. 300. 1860.

Flowers, August to October. Fruit, September to October.

DISTRIBUTION: Moist to dry sandy, loam, or clay soil; depressions among sand-dunes of beach, edges of salt marsh, or loam soil

in limestone districts, etc.; especially in old fields, almost the only *Agalinis* to be met with in cultivated soil. In the coastal plain, Norfolk Co., Virginia (where perhaps introduced); South Carolina to Louisiana, mostly near the coast. Common near the coast in South Carolina and Georgia, and apparently through most of the Florida peninsula. Apparently absent or rare in Altamaha grit region, west Florida pine hills, or inland from the coast in Alabama. In clay soil in Georgia north of the Altamaha grit. Near the coast westward to Louisiana. Abundant in alluvial districts near the lower Mississippi River, and in the hill country of West Feliciana Parish. Extending westward to Texas, and north through the lower Mississippi Valley. Casually introduced on ballast at Philadelphia.

PLANTS AND SPECIMENS EXAMINED:

Virginia: Northwest.

South Carolina: Santee Canal; St. Johns; Otranto (*4868*); Sullivan's Island (*4860*); Charleston (*4863*); Edisto Island; Aiken; Yemassee (*4849*); Beaufort; Hilton Head; Bluffton; Goat Island.

Georgia: Brunswick (*4818*); Cumberland Island; Waycross (*4792*); Naylor (*4747, 4751*); Valdosta (*4740*); Thomasville (*4735*); Cordele (*4755, 4772*); Leslie (*4761, 4766*).

Florida: Jacksonville (*4793*); St. Augustine; Orange City; Eustis; Minneola; Clarcona; Killarney; Merritt's Island; Fort Lauderdale; Miami, Alapattah; Cocoanut Grove; Homestead; Biscayne Bay; Big Pine Key; Sanibel; Polk Co.; Tampa; St. Petersburg; Fort King; Gainesville; Lake City; Monticello (*4718*); St. Marks (*4706, 4717*); Tallahassee (*4695, 4697*); River Junction (*4669*); Apalachicola (*4675, 4680*).

Alabama: Mobile; Cedar Point.

Mississippi: Ocean Springs; Biloxi (*4370*); Pass Christian (*4356*); Natchez.

Louisiana: Mandeville; Covington; Amite City; Hammond; Slaughter (*4267*); Baines (*4276*); Catalpa (*4303, 4304, 4330*).

9. **Agalinis georgiana** (C. L. Boynton) Pennell, comb. nov.

Gerardia georgiana C. L. Boynton in Biltm. Bot. Stud. 1: 148. 1902. "In the pine barrens near Cordele, Dooly County,

Georgia, in September, 1901. . . . in moist sandy soil in pine barrens. . . . The type specimens are deposited in the Biltmore Herbarium." Type, collected Sept. 18, 1901, seen in the Biltmore Herbarium.

Flowers, mid- to late-September. Fruit, late-September to October.

DISTRIBUTION: Dry sandy or clay soil, in pineland. Southern Georgia, southern Alabama, and northern Florida. Apparently occasional in flat pine woods of southern Georgia and northern Florida; near Cordele, Georgia; frequent in pine hills of western Florida and southeastern Alabama. Restricted to the coastal plain.

PLANTS AND SPECIMENS EXAMINED:

Georgia: Valdosta (*4739*); Thomasville (*4728*); Dooly Co.
Florida: Fort Gadsden (*4693*); Chipley (*4665*); Ponce de Leon (*4662*); Milligan (*4586*).
Alabama: McRae (*4609*); Florala (*4629, 4632*).

10. **Agalinis pulchella** Pennell, sp. nov.

Annual. Plant 6–10 dm. tall, widely branching. Stem angular, scabrous. Leaves spreading, linear, scabrous on the upper surface, those of the stem opposite, 2–3 cm. long. Axillary fascicles conspicuously developed, but mostly shorter than the leaves. Racemes of 4–6 mostly alternate flowers, uppermost one, by arresting of stem-apex, often suggesting a terminal flower. Pedicels slender, in flower 15–30 mm., in fruit 25–40 mm. long, much longer than the bracts. Calyx-lobes minute, less than .5 mm. long, subulate. Corolla 25–30 mm. long, minutely pubescent without, pubescent within at base of upper lobes, rose-purple, 2 yellow lines and relatively large purple spots within throat below; lobes all spreading (upper much reflexed), notched at apex, ciliate. Filaments lanose; anther-sacs ovate, evidently short-awned, densely wooly over entire surface, 3 mm. long. Style slender, 10–20 mm. long. Capsule globose, 5–6 mm. long. Seeds reticulated, with dark-brown ridges, areas between these more or less broadly hexagonal, pale, not finely reticulated.

Type, Ponce de Leon, Holmes Co., Florida, Sept. 17, 1912, *F. W. Pennell 4658*, in Herb. University of Pennsylvania.

Flowers, September. Fruit, October.

DISTRIBUTION: Dry open, sandy pineland, southern Georgia, and northern Florida, westward to Louisiana. Frequent in the Altamaha grit region of Georgia, the flat pine woods southward to the Gulf coast in northern Florida, through the pine hills of western Florida and southeastern Alabama, and in Mobile Co., Alabama. Restricted to the coastal plain.

PLANTS AND SPECIMENS EXAMINED:

Georgia: Waycross (*4779*); Douglas (*4776*); Moultrie; Thomasville (*4731*); Cordele.

Florida: Gadsden Co.; Fort Gadsden (*4692*); Chipley (*4650*, *4663*); Ponce de Leon (*4658*); Milligan (*4587*).

Alabama: McRae (*4642*); Theodore (*4427*, *4452*, *4454*, *4455*, *4493*, *4515*).

11. AGALINIS FILIFOLIA (Nutt.) Raf. New Fl. Am. 2: 65. 1837

Gerardia filifolia Nutt. Gen. Pl. N. Am. 2: 48. 1818. "HAB. In West Florida. Dr. Baldwyn." No type in Herb. Acad. Nat. Sci. Philadelphia.

Flowers, September to early-October. Fruit, October.

DISTRIBUTION: Rather dry, sandy pineland, southern Georgia and Florida. Frequent or common in flat pine woods of southern Georgia and northern Florida, south through the Florida peninsula to Miami, west to Apalachicola, and along the coast to Santa Rosa Island, possibly reaching extreme southern Alabama. Plant from Santa Rosa Island, remarkably fleshy, possibly in brackish situation.

PLANTS AND SPECIMENS EXAMINED:

Georgia: Sunbury; Brunswick (*4821*, *4828*); Waycross (*4785*); Naylor (*4752*); Valdosta (*4741*).

Florida: Jacksonville (*4800*); South Jacksonville; St. Nicholas; San Pablo (*4803*); Mayport; Pablo Beach; St. Augustine; Clarcona; Tillman; Miami; Manatee; Fort Gadsden (*4694*); Apalachicola (*4671*, *4673*); St. Vincent; Santa Rosa Island.

Alabama: ——, *Gates* (probably really from Florida.)

12. **Agalinis Holmiana** (Greene) Pennell, comb. nov.

Gerardia Holmiana Greene, Pittonia 4: 52. 1899. "Plentiful in open pine and oak groves along Michigan Avenue south of

the Soldiers' Home grounds near Brookland, D. C., collected by Mr. Holm and the writer, 20 Oct., 1898." No specimen of this date seen, but one in Herb. N. Y. Bot. Gard., of Dr. Greene's collecting, from Brookland, D. C., dated Oct. 16, 1898, may stand as the type.

Flowers, late-August to mid-October. Fruit, mid-September to October.

DISTRIBUTION: Dry sandy pineland. Long Island to Florida and Alabama; irregularly distributed. Common in the pine barrens of New Jersey, sparingly in the middle district of the same state; common on the Potomac formation between Baltimore and Washington; common in Wilmington pine barrens of southeastern North Carolina, and probably so near the coast to Charleston, South Carolina; inland probably in the fall line sand hills through South Carolina and Georgia, apparently into Alabama; at Tampa, Florida. Rather narrower-leaved and more setaceous in true pine barrens. Restricted to the coastal plain.

PLANTS AND SPECIMENS EXAMINED:

New Jersey: South River; Spotswood; Freehold; Tomlin; Franklinville; Pasadena; Woodmansie; Jackson; Atco (*3544*, *3628*); Malaga; Egg Harbor City; Absecon.

Maryland: Glen Burnie; Riverdale; Lanham; Cherry Grove (*2644*); Sligo Mill Road (*2657*); Oxon Hill.

District of Columbia: Takoma (*2655*); Lamond (*2656*); Terra Cotta (*2680*); Brookland (*2662*, *2669*); Washington.

North Carolina: Newbern; Wilmington (*4904*, *4923*, *4929*); Fayetteville.

South Carolina: Columbia; Charleston (*4864*); Aiken.

Georgia: Augusta; Burke Co.; Butler.

Florida: Tampa.

Alabama: ——, *Meisner*(?).

13. AGALINIS SETACEA (Walt.) Raf. New Fl. Am. 2: 64. 1837

Anonymos setacea Walt. Fl. Carol. 170. 1788. No type locality given, presumably should be from South Carolina, but apparently from farther west. Type in the British Museum identified by Dr. A. B. Rendle as agreeing with my number *4757*.

Gerardia setacea (Walt.) J. F. Gmel. *curante* L. Syst. Nat. ed. 13. 927. 1791.

Gerardia Plukenetii Ell. Sketch 2: 114. 1824. "Grows in wet spungy soils, very common between the Oakmulgee and Chatahouchie Rivers." Type seen in the Elliott Herbarium at the Charleston Museum. Statement of habitat probably due to confusion with *Agalinis pinetorum* Pennell.

Agalinis Plukenetii (Ell.) Raf. New Fl. Am. 2: 63. 1837.

Agalinis setacea (Walt.) Raf. As to synonymy, not description, the latter probably applying to *A. erecta* (Walt.) Pennell.

Gerardia filifolia Gatesii Benth. in DC. Prodr. 10: 518. 1846. "In Alabama (Gates!)." Type in the Kew Herbarium, identified, from fragment sent me, as this species.

Flowers, mid-September to October. Fruit, not seen, probably late-October to November.

DISTRIBUTION: Dry open sandy pineland. In the coastal plain from western Georgia and northern Florida to eastern Mississippi. Frequent from Sumter County, Georgia, westward through the pine hills of western Florida and southern Alabama to southeastern Mississippi, abundant toward the coast. One record from the Florida Keys,—Pine Key, *Blodgett*—likely due to mixing of labels. Occasional above the fall line in northern Alabama and northern Georgia.

PLANTS AND SPECIMENS EXAMINED:

Georgia: Cobb (*4757*); Cuthbert.

Florida: Apalachicola (*4672*); Milligan (*4583, 4584*); Milton (*4569, 4570*).

Alabama: Auburn; Wright's Mill; Tuskegee; Clayton; Florala (*4623*); Bay Minette (*4561*); Mobile; Spring Hill (*4524*); Crichton (*4523*); Theodore (*4426, 4457, 4461, 4517*).

Mississippi: Meridian; Biloxi (*4382*).

14. **Agalinis laxa** Pennell, sp. nov.

Annual. Plant 6–10 dm. tall, widely and very laxly branched. Stem nearly terete below, slightly angled above, glabrous. Leaves spreading, opposite nearly throughout, narrowly linear to nearly filiform, nearly glabrous, those of the stem 2–3 cm. long. Axillary fascicles scarcely or not developed. Racemes of 3–8 mostly

opposite flowers. Pedicels in flower 15–30 mm., in fruit 25–50 mm. long, 4–5 times exceeding the bracts. Calyx-lobes minute, less than 0.5 mm. long, acute. Corolla 15–18 mm. long, minutely pubescent without, pubescent with pink hairs within at base of upper lobes, pink-purple, 2 yellow lines, and small purple spots especially along these, within throat; lobes all spreading, rounded, ciliate with pink hairs. Filaments sparingly lanose, upper shorter pair nearly glabrous; anther-sacs ovate, mucronate at base, pale, lanose, 1.5 mm. long. Style 4–5 mm. long. Capsule globose-ovoid, 4–5 mm. long. Seeds nearly black, small for the genus, with relatively heavy longitudinal and connecting ridges.

Type, Brunswick, Glynn Co., Georgia, Oct. 10, 1912, *F. W. Pennell 4824*, in Herb. University of Pennsylvania.

Flowers, late-September to October. Fruit, late-October.

DISTRIBUTION: Dry sandy pineland, river sand hills and old dunes, near the coast, South Carolina to Florida. Frequent from Brunswick, Georgia to Jacksonville, Florida; no specimens seen from farther south on Atlantic Coast. One specimen from Hernando County, Florida. Probably frequent on river sand hills in lower Georgia and northeastern Florida. Restricted to the coastal plain.

PLANTS AND SPECIMENS EXAMINED:

South Carolina: Monks Corner (*4880*).
Georgia: Brunswick (*4824*); Bonnyman (*4778*); Waycross (*4783*).
Florida: Jacksonville; San Pablo (*4805*); Pablo Beach (*4801*); Hernando Co.

15. **Agalinis oligophylla** Pennell, nom. nov.

Gerardia Plukenetii microphylla A. Gray, Syn. Fl. N. Amer. II. 1: 293. 1878. "Louisiana, *Drummond*, *Hale*. Keys of Florida, *Blodgett*, &c." Louisiana material to be counted as typical. I have not seen the type. For Florida citation see under *Agalinis setacea* (Walt.) Raf.

Gerardia microphylla (A. Gray) Small, Fl. S. E. U. S. 1077. 1338. 1903; not *Agalinis microphylla* Raf. New Fl. Am. 2: 65. 1837.

DISTRIBUTION: Probably moist pineland, southern Louisiana, east of the Mississippi River at Jackson, East Feliciana Parish, more frequent westward. One old specimen seen labeled, probably incorrectly, as from Alabama. Restricted to the coastal plain.

SPECIMENS EXAMINED:

(?) Alabama: ——, *J. Torrey.*

Louisiana: Jackson.

16. AGALINIS APHYLLA (Nutt.) Raf. New Fl. Am. 2: 65. 1837

Gerardia aphylla Nutt. Gen. Plant. N. Am. 2: 47. 1818. "HAB. From North Carolina to Florida, where it was first detected by Dr. Baldwyn." Type seen in Herb. Acad. Nat. Sci. Philadelphia; accompanied by fruiting plant of *Agalinis erecta* (Walt.) Pennell.

Gerardia aphylla grandiflora Benth.* in Hook. Comp. Bot Mag. 1: 174. 1835–6. "Jacksonville." *Drummond.*

Agalinis microphylla Raf. New Fl. Am. 2: 65. 1837. "In Florida, collected by Leconte (Collins herb.)."

Flowers, mid-September to early November. Fruit, October to November.

DISTRIBUTION: Moist sandy pineland near the coast, North Carolina to Florida and Louisiana. Occasional from the Wilmington pine barrens southward, through North and South Carolina; most abundant in the flat pine woods of southern Georgia and northern Florida, frequent in the Altamaha grit region of Georgia; the west Florida pine hills; less frequent westward to Louisiana. Apparently does not occur in the Florida peninsula. Restricted to the coastal plain.

PLANTS AND SPECIMENS EXAMINED:

North Carolina: Wilmington.

South Carolina: Santee Canal.

Georgia: Thalmann (*4808*); Brunswick (*4819*); Waycross (*4789*); Coffee Co.; Naylor (*4748*).

Florida: Tisonia (*4814*); Jacksonville (*4798*); South Jacksonville; St. Marks (*4712*); Fort Gadsden (*4682*); Apalachicola (*4676*); Chipley (*4647, 4664*); Point Washington; Ponce de Leon (*4655*); Milligan.

Alabama: Mobile; Spring Hill.

* Dr. N. E. Brown has kindly consulted the Bentham correspondence at Kew, which makes it evident that this author is responsible for the treatment of *Gerardia* in Hooker's account of the plants of Drummond's collections. Also it seems evident that the paper containing this was not published until early in 1836.

Mississippi: Ocean Springs; Biloxi; Pass Christian; Nicholson. Louisiana: Abita Springs.

17. **Agalinis decemloba** (Greene) Pennell, comb. nov.

Gerardia decemloba Greene, Pittonia 4: 51. 1899. "Plant not uncommon about Brookland, D. C., inhabiting grassy knolls and hillsides bordering on pine woods." A specimen in Herb. N. Y. Bot. Gard. collected by Dr. E. L. Greene at Brookland, D. C., in Oct. 1898, may stand as the type.

Flowers, late-August to mid-September. Fruit, late-September to October.

DISTRIBUTION: Dry soil, light sand or clay, in the coastal plain in Kent Co., Delaware, frequent on Potomac formation near Washington, D. C., and probably occasional south to North Carolina. Occasional inland in the Piedmont region from Pennsylvania to North Carolina. Apparently has a fragmentary distribution, but not well understood.

PLANTS AND SPECIMENS EXAMINED:

Delaware: Felton.

Maryland: Buena Vista (*2641*); Lanham; Forest Glen; Silver Springs.

District of Columbia: Takoma Park (*2654*); Brookland (*2660, 2661, 2677, 4950*).

18. **Agalinis tenella** Pennell, sp. nov.

Annual. Plant 5–8 dm. tall, laxly branched, branches slender. Stem angled, glabrous throughout. Leaves spreading, linear-filiform to nearly filiform, acutish to acute, opposite nearly throughout, those of the stem 1–1.5 (–2) cm. long. Axillary fascicles none. Racemes of 8–12 mostly opposite flowers. Pedicels slender, in flower 8–20 mm. long, in fruit reaching 25 mm. long. Calyx-tube reticulate-venulose; lobes minute, apiculate. Corolla 15–20 mm. long, minutely pubescent without, pubescent with pink hairs within at base of upper lobes, rose-pink, 2 yellow lines and small diffused purple spots within throat; lobes all spreading, more or less emarginate, ciliate. Filaments lanose especially toward apex; anther-sacs lanceolate, mucronate at base, 2 mm. long, villose with pink hairs 1.5 mm. long. Style slender, 5–8 mm. long. Capsule globose-ovoid, much flattened at base, 4 mm. long. Seeds narrow, yellowish-brown.

Type, Thomasville, Thomas Co., Georgia, Sept. 28, 1912, *F. W. Pennell 4727*, in Herb. University of Pennsylvania.

Flowers, mid-September to mid-October. Fruit, October.

DISTRIBUTION: Dry sandy pineland, in the coastal plain from South Carolina to Florida and Alabama. Occasional in lower South Carolina; most abundant in Altamaha grit region of Georgia; less frequent in upper edge of flat pine woods of southern Georgia entering north central Florida at Gadsden County, and in middle Georgia entering east central Alabama at Lee County. In the Altamaha grit region common, mostly replacing *A. erecta* Restricted to the coastal plain.

PLANTS AND SPECIMENS EXAMINED:

South Carolina: Otranto (*4871*); Eutawville; Yemassee (*4853*).
Georgia: Waycross (*4782, 4786*); Naylor (*4744*); Douglas (*4777*); Moultrie; Thomasville (*4727*); Cordele (*4768, 4774*); Cobb (*4756*); Leslie (*4764*).
Florida: Chattahoochie.
Alabama: Auburn.

19. AGALINIS ERECTA (Walt.) Pennell, in Small, Fl. Florida Keys, 133. 1913

Anonymos erecta Walt. Fl. Carol. 170. 1788. No type locality given, presumably from Berkeley County, South Carolina. There is no type in the Walter collection in the British Museum. Of the species occurring in Berkeley County, those which best answer the description are *Agalinis Holmiana* (Greene) Pennell, *Agalinis laxa* Pennell, and the following. Of these the first two are long-pediceled, and very lax, the bracts in the first are scarcely conspicuously shorter than the peduncles, moreover both are relatively infrequent. The third species, the following, in its strict erect habit, its pedicels not conspicuously long, but with bracts conspicuously shorter, seems seems best to fit Walter's description; moreover, it appears to be much the most abundant species of the district.

Gerardia erecta (Walt.) J. F. Gmel. *curante* Linn. Syst. Nat. ed. 13, 928. 1791.

Gerardia setacea parvifolia Benth.* in Hook. Comp. Bot. Mag. 1: 174. 1835–6. "Jacksonville." *Drummond.*

Agalinis obtusifolia Raf. New Fl. Am. 2: 64. 1837. "West Tennessee, Alabama and Florida." Description in greater part or entirely of this species, though the Tennessee specimen could hardly belong here.

Gerardia parvifolia (Benth.) Chapm. Fl. So. U. S. 300. 1860.

Agalinis parvifolia (Benth.) Small in Britt. & Br. Ill. Fl. ed. 2. 3: 212. 1913.

Flowers, early-September to mid-October. Fruit, October.

DISTRIBUTION: Moist to dry sandy pinelands, in the coastal plain from North Carolina to Florida and Louisiana. Occasional or frequent in eastern North Carolina; common in the Wilmington pine barrens, and southward near the coast to Charleston, South Carolina; less frequent in the Altamaha grit region and inland in Georgia; common through the flat pine woods of Florida, south through the peninsula and on the Florida Keys; common westward through the pine hills of west Florida, decreasing inland in southeastern Alabama; and common near the Gulf coast westward to eastern Louisiana. Restricted to the coastal plain.

PLANTS AND SPECIMENS EXAMINED:

North Carolina: Rocky Mount (*4933*); Wilmington (*4910*, *4915*, *4926*); Brunswick Co.

South Carolina: Monks Corner (*4879*); Otranto (*4870*).

Georgia: Sunbury; Coffee Co.; Moultrie; Thomasville (*4733*); Leslie.

Florida: Tisonia (*4815*); Jacksonville (*4797*); San Pablo (*4804*); Green Cove Springs; St. Augustine; Big Pine Key; Marco; Fort Myers; Polk Co.; Tampa; Lake City; St. Marks (*4710*); Fort Gadsden (*4685*); Apalachicola; Chipley (*4646*, *4667*); Ponce de Leon (*4659*); Paxton (*4640*); De Funiak Springs; Milligan (*4596*).

Alabama: McRae (*4614*); Florala (*4634*); Bay Minette (*4548*, *4562*); Mobile; Spring Hill (*4526*); Theodore (*4428*, *4453*); Hollander's Island (*4503*).

Mississippi: Waynesboro; Ocean Springs; Biloxi (*4399*); Manuel; Gulfport; Long Beach; Pass Christian (*4363*); Nicholson.

*See footnote on page 433.

Louisiana: Pearl River; Bayou Lacombe; Abita Springs (*4226*, *4227*, *4231*).

20. AGALINIS TENUIFOLIA (Vahl.) Raf. New Fl. Am. 2: 64. 1837

Gerardia tenuifolia Vahl, Symb. Bot. 3: 79. 1794. "Habitat in America septentrionali." Type in Herb. Universitetets botaniske Museum, Copenhagen, Denmark, collected by Von Rohren, and said to be probably from Philadelphia, is identified by Dr. C. H. Ostenfeld as agreeing with material (my number 2681) sent from eastern Pennsylvania.

Flowers, mid-August to mid-October.

DISTRIBUTION: Moist to dry sand or loam, deciduous or mixed woodland, widely distributed and common through the eastern United States above the fall line, in the coastal plain locally frequent, especially in limestone districts. In New Jersey occasional in the middle and Cape May districts, occasional southward near the fall line; in Sumter County, Georgia; frequent in red loam soil in central northern Florida; in limestone in southeastern Alabama and western Florida; and in alluvial soil in southern Alabama and Louisiana. A larger plant southward.

PLANTS AND SPECIMENS EXAMINED:

New Jersey: New Egypt; Camden; Clarksboro; Swedesboro; Bennett; Cold Spring.
Delaware: Van Dyke.
Maryland: Ardwick (*2645*); Oxon Hill.
District of Columbia: Brookland (*2658*).
Georgia: De Soto (*4759*); Leslie.
Florida: Monticello (*4721*); Tallahassee (*4699*); Chattahoochie; River Junction (*4670*); Aspalaga; Paxton (*4601*).
Alabama: Chapel Hill, Covington Co. (*4619*); Florala (*4597*, *4606*); Cocoa; Mobile; Crichton (*4522*).
Mississippi: Meridian; Jackson.
Louisiana: Mandeville(?); Catalpa.

21. **Agalinis divaricata** (Chapm.) Pennell, comb. nov.

Gerardia divaricata Chapm. Fl. So. U. S. 299. Mar. 26, 1860. "Low sandy pine barrens." No type indicated, but abundant

material of this species collected and distributed by the describer.

Gerardia Mettaueri Wood, Class Book 530, Dec. 1, 1860. "Wet sandy places, Middle Fla. (Dr. Mettauer)." Type seen in Herb. Columbia University.

Gerardia Mettaueri clausa Wood, Class Book 530, Dec. 1, 1860. "With the others," i. e. the species and *G. Mettaueri nuda Chapm.*

Flowers, September to October. Fruit not seen.

DISTRIBUTION: Dry sandy pineland, western Florida and adjacent southeastern Alabama. Abundant through the west Florida pine hills, eastward through the middle Florida flat woods to Apalachee Bay. Restricted to the coastal plain.

PLANTS AND SPECIMENS EXAMINED:

Florida: St. Marks (*4716*); near Tallahassee; Gadsden Co.; Carrabelle; Fort Gadsden (*4684, 4687*); Apalachicola (*4679*); Chipley (*4644, 4668*); Ponce de Leon (*4657*); Portland; Milligan (*4593*); Milton (*4572*).

Alabama: Florala (*4622, 4624, 4627, 4633*).

22. **Agalinis filicaulis** (Benth.) Pennell, comb. nov.

Gerardia aphylla filicaulis Benth.* in Hook. Comp. Bot. Mag. 1: 174. 1835. "Jacksonville." *Drummond.*

Gerardia filicaulis (Benth.) Chapm. Fl. So. U. S. 299. Mar. 26, 1860.

Gerardia Mettuaeri nuda Wood, Class Book 530, Dec. 1, 1860. Under *Gerardia nuda* Wood (1870), "Middle Fl. (Dr. Mettauer, 1855)."

Gerardia nuda Wood, Am. Bot. and Flor. 231. 1870.

Flowers, mid-September to early November. Fruit, October to November.

DISTRIBUTION: Moist grassy sandy pineland, in the coastal plain from southern Georgia and northern Florida to eastern Louisiana. Frequent in the flat pine woods of southern Georgia and northern Florida; occasional or rare in the Altamaha grit region; frequent in the pine hills of western Florida and adjacent

* See footnote on page 433.

southeastern Alabama; westward near the coast to southern Mississippi and probably eastern Louisiana. Restricted to the coastal plain.

PLANTS AND SPECIMENS EXAMINED:

Georgia: Waycross (*4788*); Naylor (*4749*); Tyty.
Florida: Jacksonville (*4796*); St. Marks (*4709*); Fort Gadsden (*4689*); Apalachicola (*4677*); Ponce de Leon (*4660*); Paxton (*4643*); De Funiak Springs; Milligan (*4594*).
Alabama: McRae (*4608*); Florala (*4626*).
Mississippi: Ocean Springs; Biloxi; Pass Christian.
Louisiana: "New Orleans." *T. Drummond.*

UNIVERSITY OF PENNSYLVANIA.

Some observations concerning the reactions of the leaf hairs of Salvinia natans

Frank Marion Andrews and Max Mapes Ellis

If one observes plants of *Salvinia natans* which are in an active condition, it will be observed that the hairs on the leaves show drops of liquid which they secrete. It was noticed from time to time that some of the leaves of the *Salvinia* which was kept growing in a large tub in the green-house bore small drops of dark colored liquid. Frequently a dead dipterous insect was found on the surface of a leaf somewhat enveloped in a white fungus which was also attached to the leaf hairs. These occurrences coupled with the superficial resemblance of the leaves of *Salvinia* to those of *Drosera* suggested the possibility that this fern might also be able to absorb food from decaying matter on the leaves. It was first desirable to see if organic matter would go into solution on the leaves of this plant.

Experiment 1. Two large battery jars of *Salvinia* were isolated from the tub and small soft-bodied dipterous and thysanuran insects, such as were found in and about the tub, were crushed and placed upon many of the leaves. By the end of a week all of these insects were covered with a white fungus, apparently the same as that previously noted on the *Salvinia* in the tub. During the second week almost all of this fungus disappeared and most of the insects were reduced to drops of dark colored liquid. Only a few of the insects dried up. This experiment makes it entirely probable that some of the dark colored drops found on the leaves of the *Salvinia* in the tub contained organic remains. This reduction of the organic matter to a solution may have been the result of any or all of these three actions, (1) simple decomposition, (2) action by the *Salvinia* or (3) action by the fungus. Three experiments were made to ascertain whether or not the *Salvinia* contributes to this decomposition of the organic matter.

Experiment 2. Several large crystallizing dishes were filled with fresh *Salvinia*. On the surface of about every other leaf

was placed a small piece, approximately one millimeter cube, of the white of a hard boiled egg. The weight of the cubes was not great enough to break down the leaf hairs on which they rested. Similar cubes of the boiled white of egg were placed on clean glass in the dishes just above the surface of the water, as controls. During the first twenty-four hours all of the white of egg, both control and experiment, became rather transparent. At the end of forty-eight hours several of the leaves were removed and examined under a microscope. The cubes of egg had retained their shape perfectly, that is, there had been no rounding off of the edges as has been previously noted in the digestion of the white of egg by *Drosera*. A certain amount of the white of egg had been removed, however. Each of the leaf hairs on which the cube was resting had penetrated it and reached nearly through the block of boiled egg. The extreme tips of the prongs of each hair were thus firmly imbedded in the white of egg, but the remainder of the leaf hair scarcely touched the cube, being smaller than the chamber it occupied. This little chamber resembled a hole made in ice with a warm metal rod, being slightly larger than the leaf hair at every point except the tip. In addition to this reaction by the leaf hairs supporting the cube of white of egg, the row of hairs immediately around the cube which were not under it but which just touched it had also reacted. These hairs had bent in on all sides, penetrating the cube of white of egg in the same manner as those hairs on which the cube was resting, except that they entered the cube from the side; that is, there seemed to have been a positive chemotaxis on the part of the leaf hairs with reference to the white of egg. This experiment was continued for several days, with many plants and always with the result as just stated. Special precaution was necessary to keep the cubes of boiled egg from drying out too quickly. However, the white of egg did not injure the leaves in any way as far as could be determined during the six days it rested on them.

Experiment 3. Other cultures of *Salvinia* were isolated and small drops of *uncooked* white of egg placed on most of the leaves. Control drops of water of the same size were also placed on many leaves. The drops of both white of egg and water rested as tiny spheres on top of the leaf hairs for the first twenty-four hours.

During the second twenty-four hours the drops of white of egg in many instances broke, forming irregular patches which sank down to the surface of the leaf, completely surrounding the hairs which had supported them. At the same time the neighboring leaf hairs bent over into the white of egg in much the same manner as noted regarding the cubes of cooked white of egg. The control drops of water did not change meanwhile, remaining as spheres on top of the leaf hairs. Several things might have caused the drops of white of egg to act in this manner, but in the light of the solvent action of the leaf hairs on the cubes of cooked white of egg it seems probable that the leaf hairs themselves were responsible for the change which caused these drops of raw white of egg to change. These cultures were continued for eight days. During this time several of the drops of white of egg became infected with the white fungus already mentioned. The result was the same as that with the crushed insects. The white of egg became steadily more liquid until it was reduced to a fluid almost as mobile as water. By close observation it could be determined that in those cases where the tiny spheres of white of egg did not break and run down on to the surface of the leaf the amount of white of egg had decreased.

Experiment 4. On the leaves of fresh cultures of *Salvinia* drops of *uncooked* yellow of egg were placed. Controls were established by drops of the yellow of the egg being placed on clean glass in the dishes with the *Salvinia*, just above the surface of the water. The color of the egg on the leaves became noticeably paler than the control during the first twenty-four hours. At the end of forty-eight hours it had spread over a small area of the leaf surface in the same manner as the uncooked white of egg had done in the previous experiment. The color of this egg on the leaves was several shades lighter than the control and of a quite different consistency, being more like cream than the control. The same chemotaxis was displayed by the hairs surrounding the area covered by the egg.

Experiment 5. It was the object of this experiment to ascertain whether the plant was profiting by the presence of the decaying or soluble organic matter on the surface of its leaves. Four different jars of *Salvinia* were prepared.

In jar Number 1 the *Salvinia* was floated on distilled water.

In jar Number 2 on a nutrient solution containing the following substances:

Distilled water	1000.0 cc.
Potassium nitrate	1.0 gm.
Calcium sulphate	0.5 gm.
Magnesium sulphate	0.5 gm.
Sodium phosphate	0.5 gm.

Jar Number 3 contained a nutrient solution the same as that used in Number 2, except that the potassium nitrate was omitted. On the leaves of the *Salvinia* in this jar were placed cubes of cooked white of egg, drops of uncooked white of egg and crushed insects.

Jar Number 4 also contained a nutrient solution the same as Number 3, that is, without the potassium nitrate, but the leaves in this jar were free from foreign substances.

The *Salvinia* in jar Number 1 began to change color on the second day. The otherwise bright green color of the leaves became dull and by the fifth day there were distinct yellow spots on the leaves. In a week all of the leaves in this jar were of a uniform brownish-yellow color. In *Salvinia* care must be taken to keep the light conditions for good growth as nearly constant as possible. It frequently happens that *Salvinia* plants that have been growing in somewhat weak light will, when brought into very bright light, lose their green color and die. This, however, may be prevented by gradually bringing them into strong light which they may then stand without the least injury.

The plants in jar Number 2 remained quite normal throughout the entire experiment, which lasted fifteen days.

The leaves in jar Number 3 began to lose their color in six days and those in Number 4 four days. Both those with and without foreign matter on them finally lost all their color. By the end of the first week, however, there was a decided difference between the leaves in the two jars. Almost all of the leaves in both jars were turning yellow but those in jar Number 3 retained their color, especially, in the area immediately around that covered with organic matter. The ninth day all the leaves in both jars were yellow, excepting a few in jar Number 3. These few were still a little green in the area around the organic matter.

They continued to fade and by the fifteenth day all were entirely yellow.

This experiment shows that the plant can obtain a certain quantity of its food from the decomposing organic matter offered to it in the way above described. The amount that can be taken up by the leaf hairs, however, is small and is insufficient to supply the demands of the plant. The *Salvinia* with organic matter on its leaves seemed to have an advantage but this advantage in nature is only occasional or as chance offers.

Experiment 6. Pieces of cinder and iron filings were carefully laid on the leaves and allowed to remain for several days. No reaction of any sort occurred among the hairs of the leaves.

SUMMARY

One of the most interesting results was the chemotactic reaction of the leaf hairs. This was very distinct in every case, excepting experiment 6.

The experiments proved that the leaf hairs are capable of exerting a distinct solvent action on the organic matter placed on them. Experiments 2, 3 and 4 show this. This solvent action does not serve to remove any objectionable organic matter but the plant profits by the food derived by this action. The latter is well shown from the observations made, especially those of experiment 5. No experiment showed the leaves suffering from the presence of small amounts of organic matter on their leaves and on the contrary the leaves thus treated were the last to lose the green color as in experiment 5. The *Salvinia* may get only a small quantity of food in this way, as is indicated by the rapid decline of the plants even in experiment 5 when placed in a solution free of potassium nitrate. The positive chemotaxis of the leaf hairs, the solvent action on the cubes of cooked white of egg and the discoloring of the yellow of the raw egg coupled with the fact that in the normal habitat this fern frequently has the bodies of small soft insects which are finally dissolved on its leaves, shows at least that some food is taken in by these leaves when it is offered.

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On the relationship between the number of ovules formed and the capacity of the ovary for maturing its ovules into seeds

J. Arthur Harris

I. Introductory Remarks

In a series of papers published in part only and which need not be cited here, I have attempted by the use of the modern higher statistics to analyze the internal factors influencing seed production.

This work has consisted chiefly in determining the correlations between the degree of development of various somatic organs and the fertility of the fruit.

Certain peculiarities of the fruit itself have been also considered in their relationship to capacity for seed production or to the characteristics of the seed formed. A question of considerable interest upon which very little has been published is that of the relationship between the number of ovules formed by a fruit and its capacity for maturing these ovules into seeds. To the data of this problem the present paper is a contribution. In it only questions of fact will be considered, for it is quite premature to essay any interpretation of observed relationships in more general terms.

The problem in hand is to determine whether ovaries with a number of ovules above the average are more (or less) capable of developing their ovules into seeds than those below the average. *A priori*, ovaries with more than the mean number of ovules must be expected to produce on the average absolutely more seeds than those with less than the mean number. *A posteriori*, this condition is found almost without exception. But the question which interests the physiologist is whether ovaries of any class with respect to number of ovules are more capable of seed production as shown by their developing a higher proportion of their ovules into seeds.

This problem is not only of importance from the standpoint of

the physiology of seed production, but of considerable interest from the fact that in *Staphylea* there is a selective mortality with respect to number of ovules, ovaries with a smaller number of ovules being less capable of developing into mature fruits than those with a larger number.*

The determination of the existence of such a relationship, especially the measurement of its intensity, presents considerable difficulty. It is desirable that degree of interdependence shall be expressed in terms of correlation, but there are dangers of spurious coefficients. Again, the work so far done has demonstrated very low correlations between somatic characters, or those of the fruit, and seed production. One would, therefore, anticipate very slight relationships between the number of ovules formed per fruit and its capacity for seed development. In such cases very large and numerous series of data are desirable.

II. METHOD OF ANALYSIS

I believe the following method of reasoning is valid.

In a series (a population, to use the technical term) of polyspermous fruits only a portion of the ovules develop into mature seeds. Let o be the number of ovules formed and s the number of seeds matured per fruit; both are variable; s is always some proportion of o. If there be no relationship between the absolute number of ovules formed and the capacity of the fruit for maturing its seeds, the most probable number of seeds for any pod is po, where

$$p = \bar{s}/\bar{o},$$

the bars indicating the mean value of the two variables. Now let $z = s - po$, or the deviation of any individual s from its probable value, on the assumption that the chances of an individual ovule developing into a seed are independent of the number of ovules in the ovary in which it is produced. The correlation coefficient between o and z, r_{oz}, should furnish the information we need.

A convenient formula for the determination of this relation-

* Harris, J. Arthur, Biometrika **7**: 452–504. 1910; Science II. **32**: 519–528. 1910; Pop. Sci. Mo. **78**: 521–538. 1911.

ship was most kindly worked for me while engaged on this problem at University College, London, by Professor Karl Pearson.*

III. DISCUSSION OF DATA

This formula has been so far applied to the problem of fecundity in plants only in the case of the fruits of *Cercis*, *Robinia* and *Sanguinaria* and of the inflorescence of *Staphylea*, *Celastrus* and *Crinum*.† Only one or two published series were available for each of these species. Because of the delicate relationships which are ordinarily found between fertility and other characters‡ it is essential for trustworthy results that the relationship be worked out on as large a series of material as possible. It will be also advantageous if one can include a large number of sub-series differing from each other in the conditions to which they have been subjected but each homogeneous in itself.

The only such series of data is that used for the working out of the relationship between bilateral asymmetry and fertility and fecundity in *Phaseolus vulgaris*.§ For each of these 53 series, embodying altogether over 170,000 pods, I have carried through the arithmetical routine necessary for the determination of r_{oz}, the correlation between the number of ovules formed per pod and the deviation of the number of seeds from their probable value on the assumption of there being no relationship between the number of ovules formed and the capacity of the pod for maturing its seeds.

TABLE 1 gives the results. The key letters indicating the individual series permit easy reference to other published information concerning them. The second column shows the number of pods upon which the determinations are based. The third gives the coefficient of correlation between the number of ovules and

* Harris, J. Arthur, The Correlation between a Variable and the Deviation of a Dependent Variable from its Probable Value. Biometrika **6**: 438–443. 1909.

† For the results for the fruits of *Cercis*, and *Robinia* and the inflorescence of *Staphylea* see the original paper on methods. For *Sanguinaria* see Biometrika **7**: 321–324. 1910. For *Celastrus* see Missouri Bot. Gard. Ann. Rep. **20**: 116–122. 1909, and for *Crinum* see Missouri Bot. Gard. Ann. Rep. **23**: 85–89. 1912.

‡ For a review of the pertinent literature for plants see Biometrika **8**: 52–65. 1911.

§ Harris, J. Arthur, in Roux's Archiv. f. Entwicklungsmech. Organism. **35**: 500–522. 1912.

TABLE I

Series	N	r_{os}	r_{oz} and Probable Error	r_{oz}/Er_{oz}
L	1804	.374	−.040 ± .016	− 2.52
LL	8043	.357	−.014 ± .008	− 1.80
LG	806	.107	−.189 ± .023	− 8.27
BW1	346	.177	−.234 ± .034	− 6.82
BW2	467	.128	−.290 ± .029	−10.15
G	696	.542	−.012 ± .026	− .47
GG	6310	.247	−.102 ± .006	−17.25
GGH	5251	.461	−.101 ± .009	−10.98
GGH2	3502	.517	−.045 ± .011	− 3.94
GGHH	2656	.489	−.068 ± .013	− 5.20
GGD	1438	.362	−.069 ± .018	− 3.88
GGD2	1227	.426	−.020 ± .019	− 1.04
GGDD	807	.386	−.022 ± .024	− .95
H	5141	.444	+.012 ± .009	+ 1.23
HH	14029	.511	−.015 ± .006	− 2.68
HHC	2355	.504	+.121 ± .014	+ 8.82
HHH	11230	.426	−.057 ± .006	− 9.02
HHHC	2614	.501	+.101 ± .013	+ 7.69
HD	5581	.418	−.040 ± .009	− 4.47
HDC	1733	.509	+.086 ± .016	+ 5.32
HDD	5449	.500	+.026 ± .009	+ 2.87
HDDC	2308	.464	+.097 ± .014	+ 6.97
D	1473	.521	+.055 ± .018	+ 3.17
DD	1827	.496	−.046 ± .016	− 2.91
DDC	1159	.463	+.066 ± .020	+ 3.35
DDD	2018	.444	−.018 ± .015	− 1.17
DDDC	1542	.429	+.047 ± .017	+ 2.77
DH	5955	.548	+.029 ± .009	+ 3.29
DHC	2077	.409	+.045 ± .015	+ 3.05
DHH	5019	.446	−.052 ± .010	− 5.48
DHHC	2494	.438	+.055 ± .014	+ 4.06
USC	2569	.331	−.064 ± .013	− 4.79
USS	6605	.505	+.071 ± .026	+ 2.78
USSC	1888	.332	−.065 ± .016	− 4.21
USH	3406	.470	−.041 ± .012	− 3.60
USHC	1570	.322	−.091 ± .017	− 5.38
USHH	1743	.366	−.035 ± .016	− 2.18
USHHC	1936	.318	−.106 ± .015	− 6.95
USD	802	.376	−.018 ± .024	− .74
USDC	1810	.245	−.154 ± .016	− 9.91
USDD	851	.370	−.027 ± .023	− 1.17
USDDC	1619	.315	−.116 ± .017	− 7.05
FSC	2876	.344	−.056 ± .013	− 4.50
FSS	7809	.367	−.049 ± .008	− 6.42
FSSC	2457	.411	+.035 ± .014	+ 2.57
FSH	4541	.458	−.004 ± .010	− .38
FSHC	2117	.268	−.155 ± .014	−10.84
FSHH	3837	.398	−.028 ± .011	− 2.59
FSHHC	3180	.325	−.089 ± .012	− 7.43
FSD	1449	.433	+.002 ± .018	+ .12
FSDC	1506	.267	−.134 ± .017	− 7.83
FSDD	1556	.421	−.016 ± .017	− .92
FSDDC	2646	.328	−.101 ± .013	− 7.73

number of seeds per pod, r_{os}, while the fourth contains the correlations between the number of ovules per pod and the deviation of the number of seeds from their probable value.

All of the values for r_{os} are positive, and of a substantial order of magnitude. Both positive and negative coefficients for r_{os} occur, and the values are low throughout. Of the 53 determinations, 38 are negative and 15 positive in sign. Were there no biological relationship between *o* and *s* an equal number of positive and negative values would be expected. Thus there is a deviation from equality of 11.5 ± 2.46,* which is probably significant.

Thus there is apparently a distinct negative relationship between *o* and *z*. This conclusion is supported by restricting the constants upon which it is based to those which are more probably statistically significant with regard to their probable errors. Thus I find that for the 41 constants 2.5 and more times their probable error 28 are negative and 13 are positive. Of the 26 constants which are over 4 times their probable error, 21 are negative and 5 are positive. Of the 13 which are over 7 times their probable error, 11 are negative and 2 are positive.

Taking means of the ratio of the correlation coefficients to their probable errors, I find a mean ratio of 5.10 for the negative values and of 3.87 for the positive. Thus the negative constants are as a whole more trustworthy than are the positive, although some of the positive values must be certainly regarded as trustworthy statistically.

Consider next the relative magnitude of the positive and negative coefficients. The 38 negative constants give a mean value of $-.0732$ while the 15 positive correlations give a mean value of $+.0529$. Thus the negative coefficients are numerically larger than the positive.

I now split the materials up into the individual varieties. The results are conveniently summarized in TABLE II.

Positive coefficients occur only in Navy, Ne Plus Ultra and White Flageolet. In the two latter, only 3 of the 22 constants are positive, and neither of the three can be safely regarded as significant with regard to its probable error. In Navy, quite different conditions seem to prevail. In both strains 6 of the 9

* Calculated from $.6745\sqrt{53 \times .5 \times .5}$.

constants are positive. Numerically, the positive constants average higher than the negative, and in comparison with their probable errors they seem to be more trustworthy, the values of the ratio of r_{oz} to its probable error averaging higher in the positive than

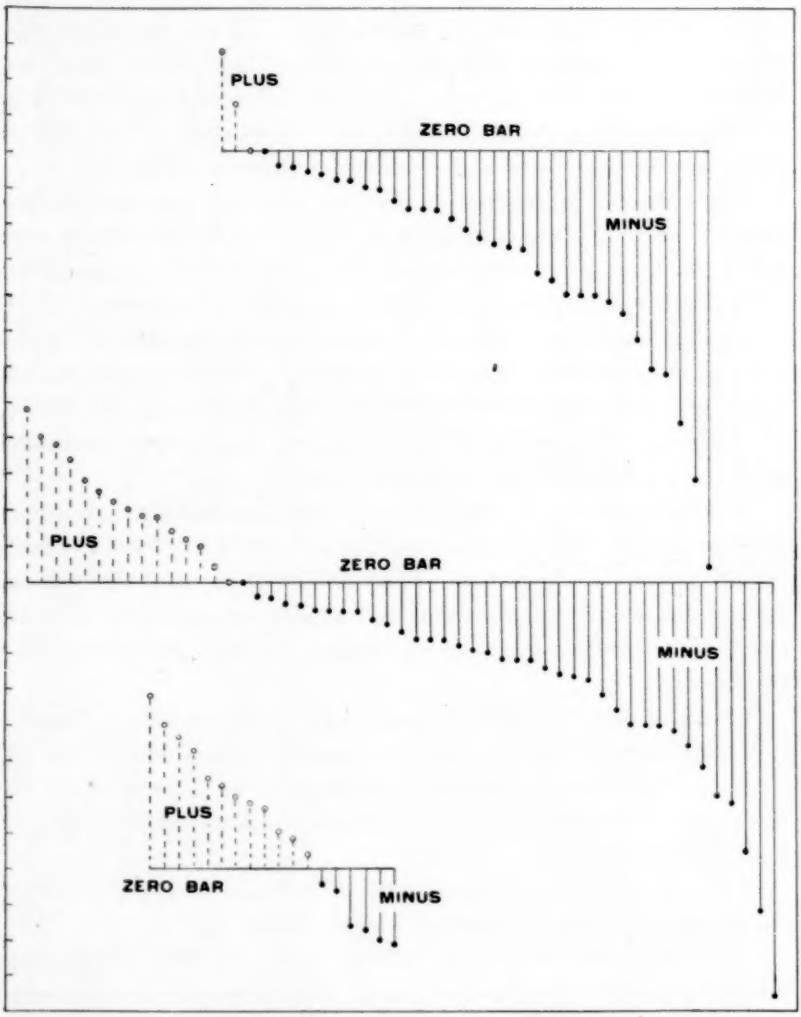

DIAGRAM 1. Intensities of correlation. One interval on marginal scale = .052.

in the negative cases. Just the reverse of this condition is found everywhere else. All of the positive values which are over thrice their probable error fall in the Navy strains.

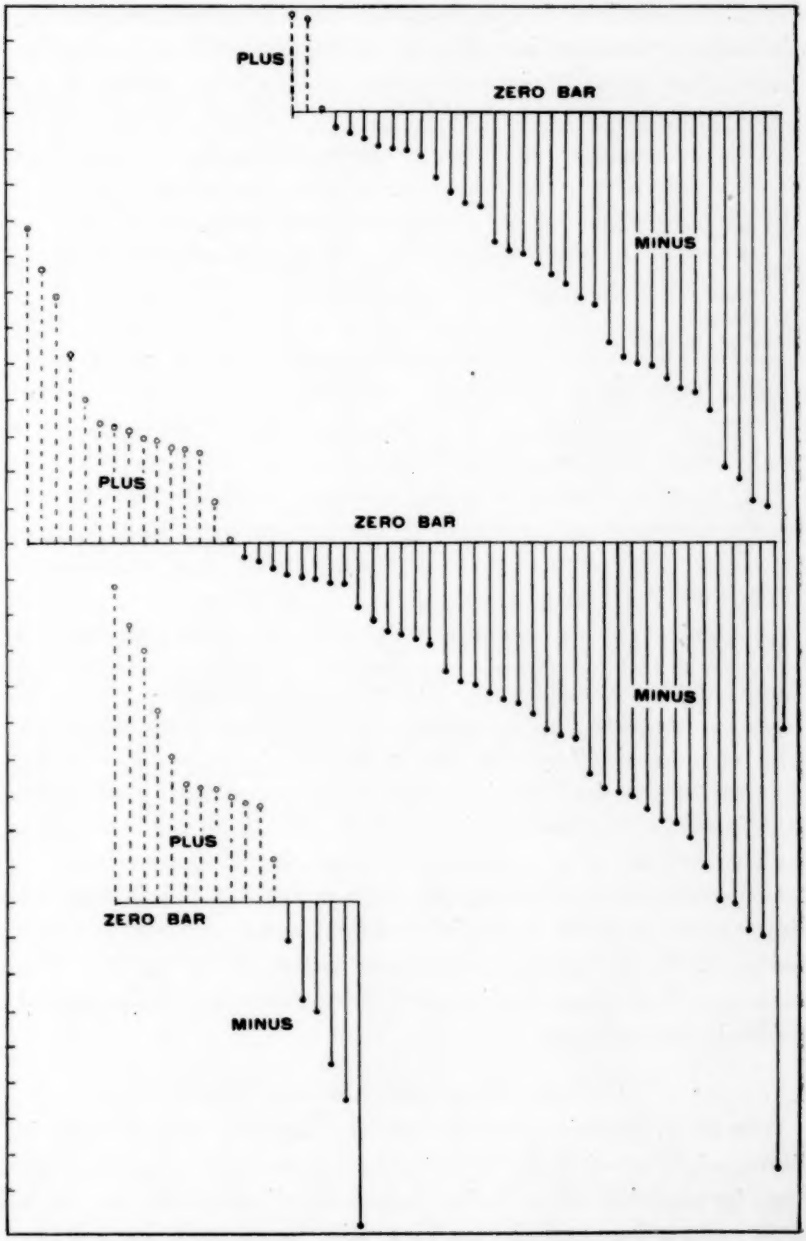

DIAGRAM 2. Significance of correlations as indicated by the ratio to their probable error. One interval on marginal scale = 1.

These relationships are forcibly shown in DIAGRAMS I and II. In both of these the intensity of the correlation is shown by the

TABLE II

Variety	Number of cases	Mean r_{oz}	Mean $r_{oz}/E_{r_{oz}}$
Golden Wax			
Plus	—	—	—
Minus	3	−.081	−4.20
Black Wax			
Plus	—	—	—
Minus	2	−.262	−8.49
Burpee's Stringless			
Plus	—	—	—
Minus	8	−.055	−5.46
Navy H			
Plus	6	+.074	+5.48
Minus	3	−.037	−2.70
Navy D			
Plus	6	+.050	+3.28
Minus	3	−.039	−3.19
Ne Plus Ultra			
Plus	1	+.017	+2.78
Minus	10	−.072	−4.60
White Flageolet			
Plus	2	+.014	+1.35
Minus	9	−.070	−5.40

length of the vertical lines. The broken ones extending above the zero bar measure positive values; the solid ones extending below the zero bar indicate negative coefficients. In DIAGRAM I the lengths of the lines are in terms of the correlation coefficients, r_{oz}; in DIAGRAM 2 they are in terms of the ratio of the correlation to its probable error. In both, the large central figure represents the distribution of values for the whole material. This is analyzed into the Navy series, shown in the lower corner, and into all other series, shown in the upper right hand corner of the figures. The difference in the contribution of these two elements to the general series is very striking.

IV. RECAPITULATION AND DISCUSSION

In dwarf varieties of garden beans, *Phaseolus vulgaris*, there is but a slight relationship between the number of ovules per ovary and its capacity for maturing these ovules into seeds. So lax is this correlation that in working with only moderately large samples both positive and negative values of the coefficient may be found in the same strain of material.

Such a relationship does, however, exist. So far as the materials available may be considered as representative of the species it is generally negative, i. e., as the number of ovules formed increases the capacity for maturing these ovules into seeds decreases. This conclusion is supported by the facts that the negative correlations are significantly more numerous than the positive, they average larger numerically, and they have a higher degree of trustworthiness with regard to their probable errors.

In some varieties, however, the correlations seem to be generally positive. This is true for the common Navy. All other varieties so far as studied—White Flageolet, Ne Plus Ultra, Burpee's Stringless, Golden Wax and Black Wax—show exclusively or preponderantly negative correlations.

Concerning the explanation of this relationship no suggestion can be made. Such an attempt would be quite premature until ample quantitative data on the nature (sign) and intensity of the relationship in a considerable series of varieties are available. Anyone venturing to suggest explanations must also fully realize that the problem is an exceedingly complex one, involving many difficulties which need not be enlarged upon here. But as matters of biological fact the results seem definitely established, and represent one further step in the analysis of the problem of fertility and fecundity in plants.

COLD SPRING HARBOR, N. Y.

INDEX TO AMERICAN BOTANICAL LITERATURE

(1913)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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